CASE MARKET AND OPPORTUNITIES

1988 - 1993

INPUT

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Abstract

This report provides an assessment of the emerging Computer-Aided Systems Engineering (CASE) market. CASE involves the use of information technology to control and improve the effectiveness of the systems development process, which remains one of the major constraints to the successful deployment of computing technology throughout today's modern organization.

This report frames the market for CASE with a historical perspective of software productivity. In addition, user acceptance of CASE technology is assessed, a five-year forecast of the market is presented, and the leading and emerging vendors are profiled.

The report analyses the fundamental issues faced by vendors and users of CASE technology, highlights the trends and market directions, and provides recommendations to both parties.

The report contains 184 pages including 42 exhibits

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I

Introduction

Introduction

This report and the related research was performed as part of INPUT's Market Analysis Planning and Information Systems Planning programs. These programs serve the management of leading vendors in the information services industry and the information systems function of large organizations.

A
Scope

Computer-Aided Systems Engineering (CASE) is the current answer to a challenge that has faced the information systems process from the first generation of computing: How to build quality systems that truly meet the requirements of those to be served, and to do so on time.

CASE, as a standard term in the industry, has become loosely defined and used. It seems that either every vendor of an application development product has added CASE technology or relabeled its current technology. This type of definition does not truly define the world of CASE nor does it provide the framework required for an in-depth assessment.

In simple terms, CASE is the application of computer-based technology to the entire information systems specification, design, and programming process. It is the using of the computer to perform tasks that require significant amounts of human energy, while increasing the consistency and quality of the resulting application. CASE technology is intended to address the problems of productivity, quality, and maintainability of systems.

- Productivity is the speed with which the systems development process can provide a solution to an information requirement.

- Quality is the manner in which the resulting system meets the requirements of the using organization and the reliability with which the system operates.

- Maintainability is the ease with which a system can be adapted to changing requirements (or fixed if a problem exists).

As such CASE is more than a fourth-generation language or a data modeling tool. CASE is the act of turning the systems development process into an engineering process. To understand CASE and the impact it has on the systems engineering process:

- CASE must be viewed in a broad sense.

- Case must be recognized as more than just the use of technology to perform a task.

- CASE users must consider the human aspects of the adoption process.

The information systems professional has been challenged and criticized since the early days of the profession to be more responsive, productive, and to build more successful systems. CASE products offer yet another opportunity for the profession to respond to the changing requirements of those it serves. To do so, however, requires a cultural change as well as the adoption of new tools and technology.

In this report INPUT views the CASE opportunity as follows:

- From a technical point of view, CASE is a total development environment including a development language, data base environment, a data dictionary or repository, a graphical environment for development, and an integrated workbench spanning the entire development life cycle.

- From a humanistic point of view, CASE is the integration of the phases of systems engineering through the use of graphical and code generation tools that permit a system to be developed without writing code. Developing a system becomes purely a specification process.

The effects of CASE can be equated to those of the personal computer and end-user computing in which the humanistic elements of the process of change were often of greater impact than the technological elements.

B
Objectives

The primary objective of this report is to provide vendors and users with an understanding of the driving forces and trends in the emerging market for CASE products. CASE as a term has been around for some time, but as a real technology and a market is still young and seeking its true definition.

The individual objectives of this report are:

- Provide an overall view of the software development environment as it provides a foundation for the CASE opportunity

- Analyze the driving forces, trends, and issues that are part of and are affecting the CASE market

- Assess the requirement for and reception of CASE in the user community, and identify the requirements for success

- Identify and characterize the leading and emerging vendors of CASE tools

- Dissect the competitive environment of the CASE market and analyze the opportunities and requirements for success

- Provide a forecast of the U.S. market for CASE tools

Some would say that there is a crisis in the systems development area today, others would say that crisis has existed for 10 to 15 years. Development backlogs have grown to the point where they are essentially a fixture in the development environment, user requirements are increasingly complex, the user is performing an increasing portion of the development effort, and the demand for responsiveness is increasing. It is in this light that the costs, benefits, and directions of CASE are analyzed in this report.

This report includes a look at many of the leading vendors of CASE products, including vendors specializing in CASE technology and those that include CASE products within a broader product line. The report positions the individual vendors and their apparent strategies, but does not include an assessment of the individual CASE products.

C
Methodology

The research for this report includes the following:

- Interviews with numerous CASE vendors concerning their products, their views of the market, and their strategic direction

- Discussion with various experts in the area of CASE

- Structured, in-depth interviews with 100 directors of the systems development function in large organizations

- Structured interviews with 15 managers responsible for the introduction of CASE into a systems development environment

The vendor interviews resulted in the profiles in Appendixes A and B, and are responsible for the overall characterization and forecast of the market.

The questionnaire for the interviews with application development directors is included as Appendix C. It was designed to determine:

- The makeup, priorities, and issues facing this oft maligned organization

- The current application backlog, allocation of resources, use of external resources, and package software

- The level of priority being given the productivity issue: How is it being addressed and what is the level of activity with CASE

- The amount of development activity by the end user

The second user questionnaire, Appendix D, was used to interview project leaders currently using CASE. The goal was to determine the rate and level of progress, and the problems being encountered.

D

Report Structure

The remaining chapters of this report are organized as follows:

- Chapter II is an Executive Overview providing a summary of the contents of the entire report.

- Chapter III, Software Productivity—A Perspective, provides a back-drop for this assessment, tracking the history of the software productivity and positioning the opportunity for CASE technology.

- Chapter IV, Market Analysis and Forecast, provides INPUT's description of the CASE market: the opportunity, the driving forces, and the forecast.

- Chapter V, User Perspectives, provides an assessment of the application development environment within which CASE must be deployed, and the implications this environment has for the success of CASE technology.

- Chapter VI, Competitive Environment, is an assessment of the competitive environment, leading vendors, and their strategic directions.

- Chapter VII, Conclusions and Recommendations, provides conclusions and recommendations for vendors and users.

- The appendixes contain:

  - Appendix A, profiles of leading independent CASE vendors

  - Appendix B, CASE product profiles of vendors that participate in more than the CASE market

  - Appendix C, Application Development Questionnaire, used to survey over 100 directors of application development in large organizations

  - Appendix D, CASE Implementation Questionnaire, used to survey project leaders responsible for implementating CASE within large applications development functions

E
Related Reports

The following INPUT reports relate to this report on CASE:

Computer-Aided Software Engineering in Europe, 1987-1992

Software Productivity, 1986

Future DBMS Markets, 1987-1992

Information Systems Planning Report, 1988

Professional Services Market, 1988-1993

Software Products Market, 1988-1993

II

Executive Overview

II
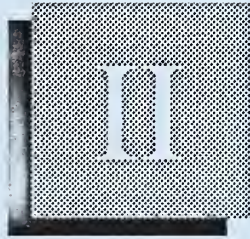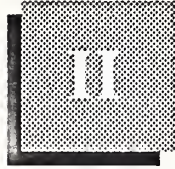
Executive Overview

This chapter provides a summary of the report that follows, and provides an overview of a dynamic and challenging market and technology, Computer-Aided Systems Engineering (CASE).

A

The Challenge

The challenge that CASE addresses is a simply stated one—improve the productivity and the quality of the systems development process. This challenge is long-standing, having first been encountered with the first-generation of computer languages and re-encountered with each subsequent generation.

The systems development productivity and quality challenge in the 1990s is best depicted by Exhibit II-1. Over the past two decades the complexity of the business requirement being addressed by information technology has grown immensely.

It is now necessary to change the terminology used to describe the requirements addressed by the systems (application) development process. From the original—data processing—to today's strategic information systems, the focus on and expectations from the development process have changed extraordinarily.

EXHIBIT II-1

CASE—THE CHALLENGE
COMPLEXITY OF THE REQUIREMENT

Strategic Info Systems

Mission-Critical Systems

Distributed Processing

Interactive Systems

Applications

Data Processing Systems

Complexity

| 1970 | 1980 | 1990 | 2000 |
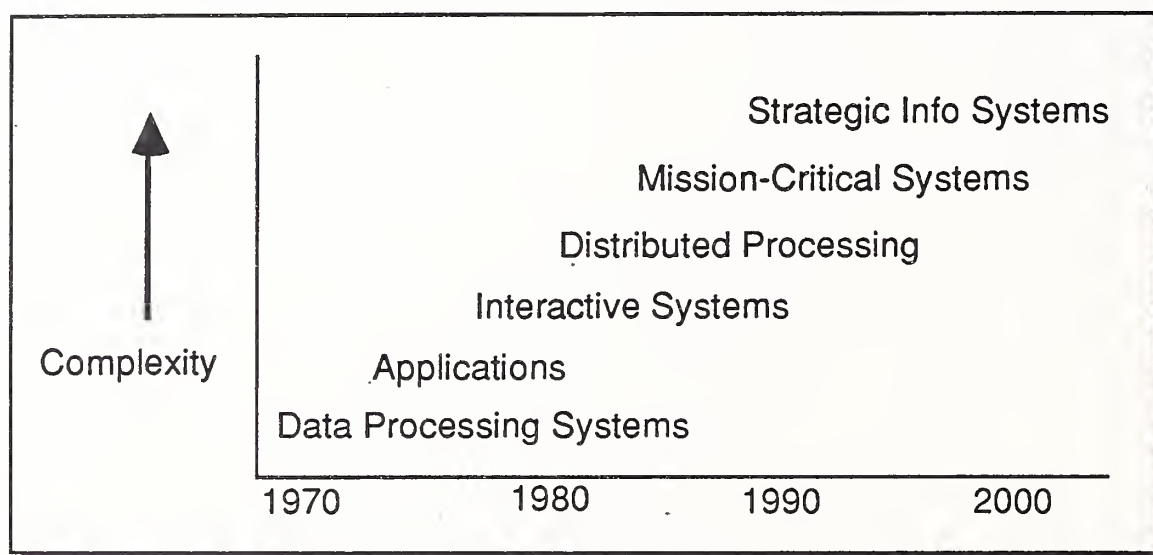
B

The Opportunity

The opportunity for the application of computing technology to the systems development process is comparable to the gains in the engineering profession with CAD/CAE technology and systems. If the systems development process can be turned into a true engineering process, then the power of computing can bring similar benefits.

In this light, the opportunity and the requirement, is that defined in Exhibit II-2. CASE must, in the eyes of the user, address the entire development life cycle, including the project management, maintenance, and support processes.

Prior attempts to address productivity issues have often been paper-based and/or have only addressed one or perhaps two of the phases of the life cycle. As such they have not been adopted in a uniform manner and have routinely fallen short of the original expectations.

• The paper project management processes of the 1970s usually proved to be too laborious to perform in a disciplined fashion except for the largest of projects.

EXHIBIT II-2

CASE—THE OPPORTUNITY
THE DEVELOPMENT LIFE CYCLE

Project Management

Requirements

Analysis

Functional Specification

Design Specification

Coding & Test

System Integration

Release & Acceptance

Application

Maintenance & Support
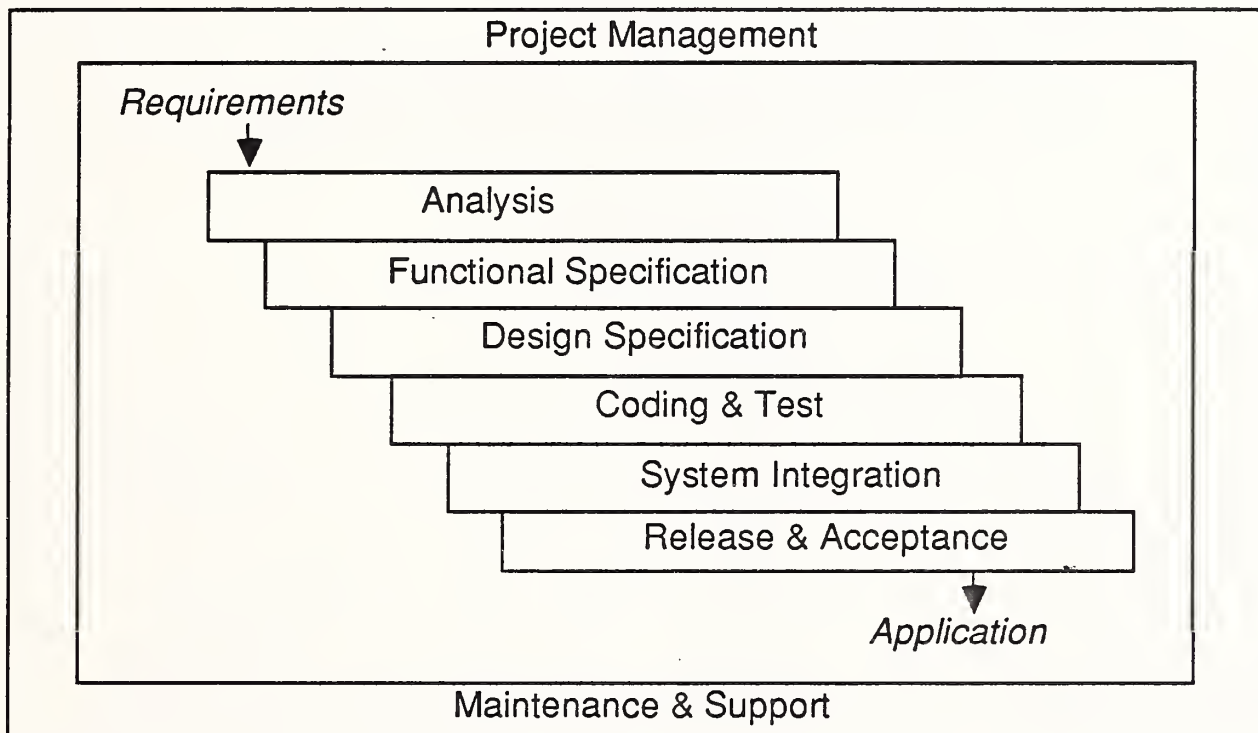
- Fourth-generation languages, although truly speeding the programming process, have proven to have severe limitations for certain types of systems.

- All of the structured analysis and design techniques provided an improvement in the front-end process, but they fell short in the translation process performed by the programmer.

So the real opportunity is to surround the entire life cycle. The CASE technology currently available, as well as future technology, presents a very significant start in this direction.

C
CASE Framework

The tools that are currently marketed under the CASE label are numerous and diverse. They range from first-generation I-CASE (integrated front- and back-end tools) to specialized software products that perform one task within the testing environment. They support the design process in a graphical fashion, guide the data base definition process, generate code, or help re-engineer an existing application.

Exhibit II-3 provides a schematic of a complete CASE system. It consists of a single graphics-based user interface that interacts with the various subsystems that support the entire life cycle.

EXHIBIT II-3

CASE TECHNOLOGY FRAMEWORK
COMPLETE CASE SYSTEM—SCHEMATIC

Project Management

Diagramming and Specification Tools

Graphics Screen

Design Analyzer/ Checker

Code Generator

Automated Repository

Functions, Processes, Procedures, Data Models, Process Models, Business Models, Data Dictionary
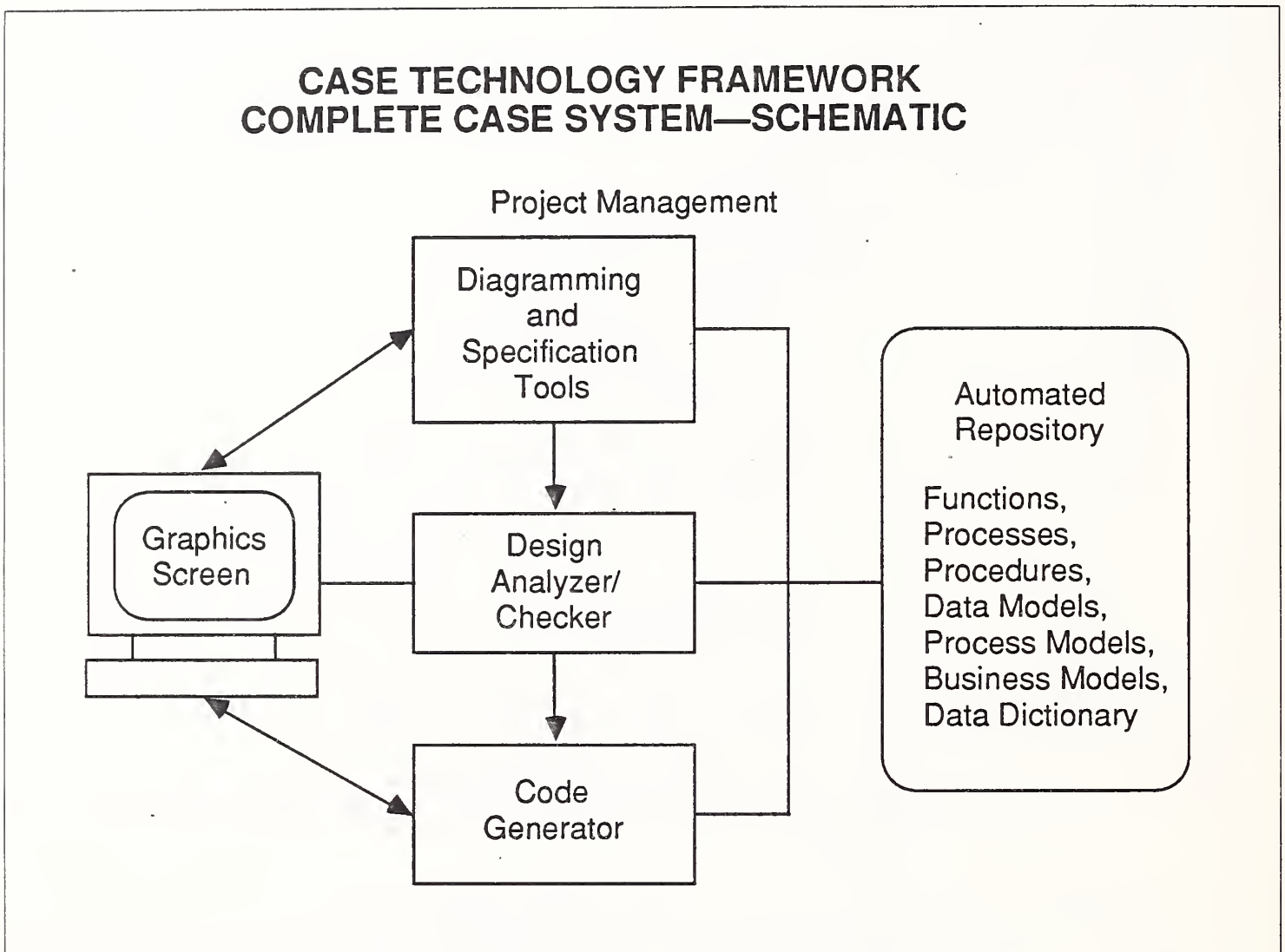
- These subsystems include project management, design and specification tools, logic analyzers and data base modeling tools, a code generator, and implementation support tools.

- All of these tools will be supported by an automated repository that serves as the control mechanism and the documentor of the system. It is through the repository that the maintenance process can benefit.

In its full or complete definition, a CASE system is called I-CASE. The interfaces between the various tools and with the repository are automated and tightly integrated.

D

Market Framework	The current CASE market can be characterized as described in Exhibit II-4.

EXHIBIT II-4

CASE MARKET FRAMEWORK

- Still Emerging

- Supported by New and Established Vendors

- Using Workstation and Mainframe Technology

- Using Creative New Technology

- Segmented by Buyer and Application

- Still emerging: The term CASE was hardly used before 1987 and remains loosely used by many vendors who want to be on the bandwagon.

- Supported by new and established vendors: The current leaders (Index Technology and KnowledgeWare) are independent, but are closely pursued by Pansophic and Texas Instruments.

- Using workstation and mainframe technology: The front-end tools are primarily PC- and workstation-based, the back-end tools are mainframe- or central processor-based.

- Using new and excitin; technology: Although reasonably well developed and in general use, this area remains open to further significant development.

- Segmented by buyer and application: The three sectors are information systems development, real-time systems, and commercial software products.

    - The information systems development sector is by far the largest and has attracted the attention of most of the vendors.

- The information systems development sector has the most cautious buyers, the information systems function of large organizations.

- The real-time systems sector may be the most advanced, due the willingness of these users to experiment. They are much closer to the definition of an engineer and have less of a cultural change to make.

The strategies of the CASE vendors are numerous and typical of an emerging market. Because there is no dominant vendor the market remains open to new entries and advances. Success requires a fast pace.

E

Market Forecast

The U.S. market for CASE products was $125 million in 1987 and will be $215 million in 1988 for a 72% overall growth rate. Penetration is still modest at about 5%.

Exhibit II-5 provides INPUT's five-year forecast for the U.S. market from 1988 to 1993. Over that period the market will expand to over $1.4 billion with a growth rate twice the rate for the software market as a whole. CASE is a market that is attracting the attention of almost every software and hardware vendor.

EXHIBIT II-5

1988-1993 CASE FORECAST

Bar chart: ($M) User Expenditures on the vertical axis (0 to 2000). 1988 = 215; 1993 = 1,420. CAGR 46%.
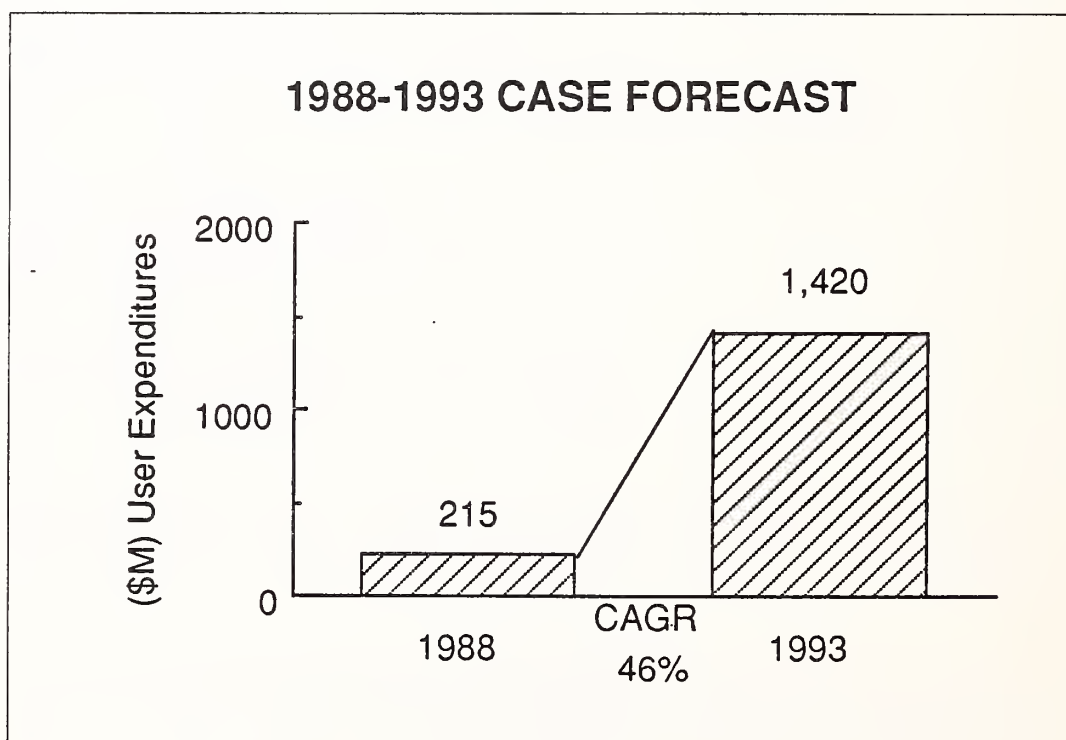
The CASE market currently includes a great many alliances between vendors.

- As the market has taken shape, alliances have been formed for competitive advantage, for expansion of the breadth of a vendor's technology, and for providing professional services companies with access to a CASE environment for use in their systems development practice.

- INPUT expects some of these alliances to become more permanent through merger and acquisition over the next few years as the stronger companies strive for a full I-CASE product line.

Currently, there are perhaps 200 vendors who claim participation in the CASE market at this time. Many will disappear as the move to a full product line requirement gains momentum. The buyer (information systems) is already indicating this is a key selection criteria.

F
User Perspective

The user, defined for this report as the information systems function of larger organizations, faces a perplexing challenge today.

- The application development backlog never goes down.

- The maintenance requirement just gets bigger.

- The requirements of the user become ever more complex.

- The cry from management is for greater return from IS through productivity and the euphemism, "build mission-critical systems."

- Systems quality remains a moving target as the applications and networks become ever more complex.

Thus when the user looks at CASE they do so with the perspective defined by Exhibit II-6.

The information systems sector wants CASE to address all of its broad development issues, not just programmer productivity or the design process. This makes IS cautious. It does not see a great deal of benefit in the maintenance area, nor a basis to bet on any one vendor. Is has other priorities that make it easy to let a commitment slip.

The attraction of CASE is not lost, however. The majority of IS organizations are at least taking a look and the experimentation level is rising. What users and vendors need are enough users that have passed beyond the experimentation stage into true use followed by general use by the entire development function. The next two years should bring that level of progress.

EXHIBIT II-6

CASE OPPORTUNITY—USER PERSPECTIVE

- CASE Must Address Systems Quality, Perhaps Even More than Productivity.

- CASE Must Provide Assistance to the Current Maintenance Challenge as Well as the Future Challenge.

- CASE Must Help IS Benefit from the Expanding Sources of Development Resources.

- CASE Must Support the Growing Complexity of Application Requirements and Not Stifle Creativity.

G

Competitive Environment

The background of the most active CASE vendors can be classified as follows. The differences in their foundations reflect to some degree in their strategies.

- Tool Developers—A strategy based on technology, not methodology of systems development

- Methodology-Based Companies—CASE vendors that are computerizing a particular methodology (approach) to the life cycle

- DBMS/4GL Companies—Developers of other application development tools that believe they need to move back up the life cycle to maintain client control while opening new market opportunities

The role of alliances has already been identified as a key competitive tactic. The second competitive issue is the state of the technology. There are instances of front-end CASE vendors leaping past their competitors with the latest capabilities.

- The market is young enough to permit new entries.

- The largest leader has only 15% of the U.S. market and is only a front-end tool developer. The third-largest vendor is a only back-end/code generation developer.

- The fastest-growing companies seem to be those claiming to offer a full, if less than fully integrated, I-CASE product line.

H
Recommendations

Exhibit II-7 lists INPUT's requirements for success, first for users and then for vendors.

The user—the information systems department—is challenged to change the way it performs its job. The capabilities exist to turn systems development into an engineering process.

- It requires a significant cultural change and a very open mind by technicians in the application of technology.

- If the information systems sector does not move forward with CASE, it is very likely that its role will decline over time relative to the development of major new systems.

- Other development sources currently exist, specifically the professional services/systems integrator that is using CASE to run its business.

The CASE vendor community is challenged to push forward with the technology and concentrate on the I-CASE target.

- Information systems wants to use a single vendor to support the magnitude of change required.

- CASE vendors need to provide all aspects of support, not just the technology.

- The CASE community needs to accept some of the progressive changes of the software industry at large, specifically standards and an open architecture.

EXHIBIT II-7

CASE—REQUIREMENTS FOR SUCCESS

User Requirements

- Experiment with the Technology, Do Not Just Conduct an Assessment.

- Understand the Depth and Breadth of the Impact of CASE on the Development Culture.

- Adopt an Active, Well-Disciplined Development Methodology.

- Make a Strong Commitment to Structured Analysis and Design Techniques.

- Do Not Ignore the Maintenance Challenge When Considering CASE.

- Set Well-Defined Objectives for CASE and Measure Progress.

Vendor Requirements

- Provide the Support Services to Achieve Full Customer Implementation.

- Serve the Maintenance and the New Development Requirements.

- Strive for a Full Life Cycle Product Line.

- Provide a Full-Function Repository.

- Develop and Maintain an Open Architecture.

- Support Multiple Methodologies.

- Plan for the Next Generation of CASE Users—the End Users.
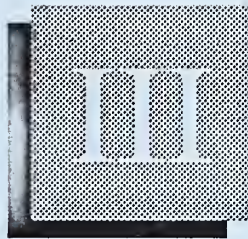
Software Productivity—
A Perspective
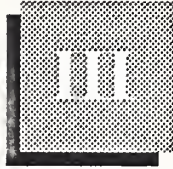
Software Productivity—
A Perspective

In this chapter INPUT sets a structure for the analysis of the CASE market and opportunity. A historic look at the systems productivity challenge is provided, and the current information systems development challenge is examined. Also discussed are the emergence of CASE and the underlying elements of CASE technology. INPUT's goal is not to recite prior research, but to establish a common perspective with which to view current and future CASE progress.

A
Software Productivity— The Challenge

The software productivity issue traces its origin to the beginning of the information age. Starting with Autocoder and continuing to the most recent programming productivity revolution of fourth-generation languages, the software productivity problem has been attacked, conquered to some degree, and reborn. Numerous studies by INPUT and others have analyzed and dissected the productivity question and have often come to the same conclusions: "Productivity is a management problem not a technology problem. Technology can help, but in the end it is the management process that drives the overall productivity and quality of the systems development process."

To position the current attack on software productivity, labeled Computer-Aided Software Engineering, INPUT refers to previous studies. In 1980, INPUT published the report, *Managing the Systems Development Process* and in 1986 published *Software Productivity*. Both of these reports reach common and consistent conclusions.

1. Systems Development Time Distribution

Exhibit III-1 provides a historic view of the time distribution of the systems development process. Starting with a study by IBM in 1964 and reconfirmed in INPUT studies in 1980 and 1986, the allocation of time between requirement and design, programming, testing and debugging, and documentation has remained relatively unchanged. All of the productivity tools provided to that date have not significantly affected the tasks and their relative time requirements.

EXHIBIT III-1

SYSTEMS DEVELOPMENT PROCESS
TIME DISTRIBUTION—1964/1980/1986
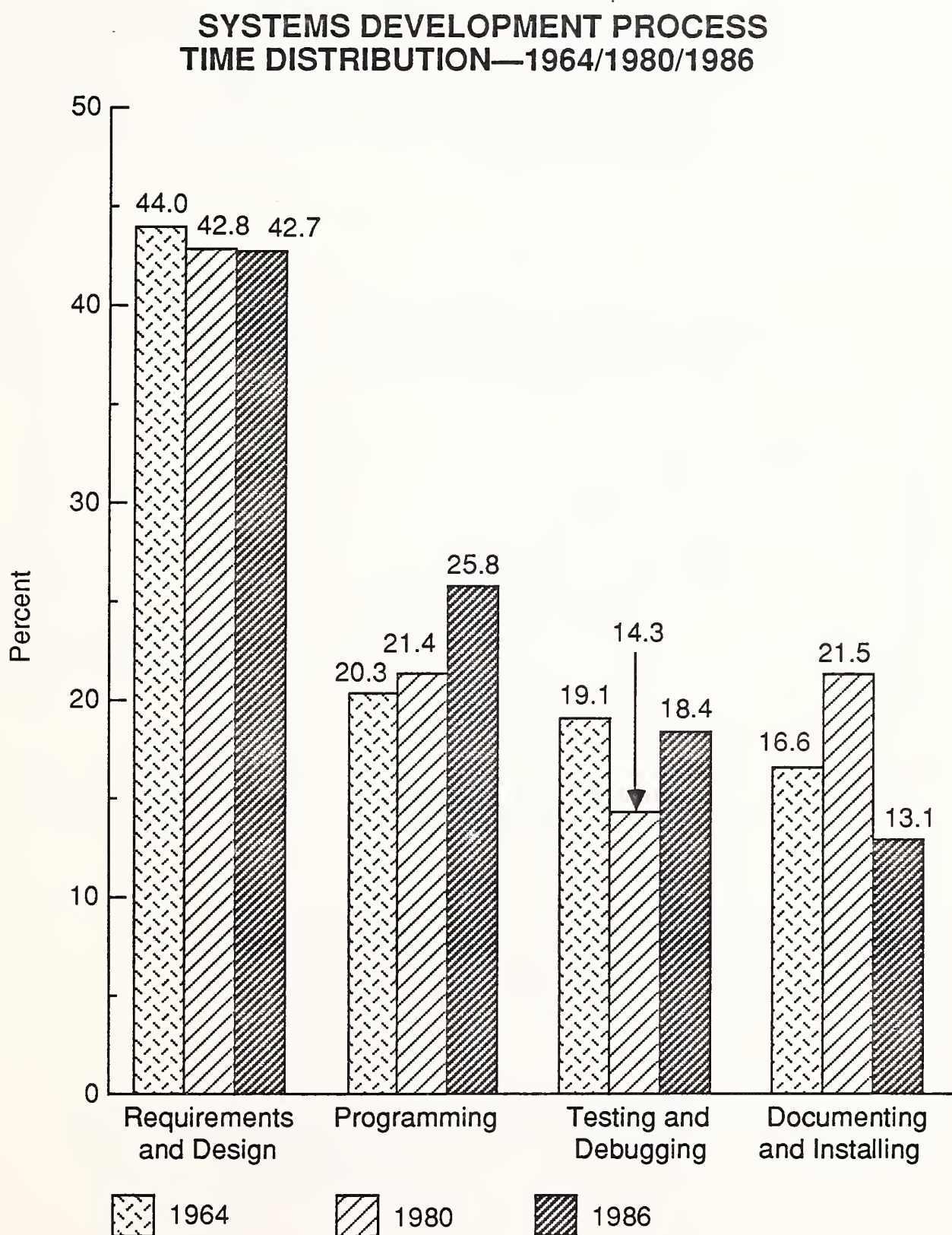
2. Productivity Pyramid

INPUT first put forth the concept of the *productivity pyramid* in 1980. As shown in Exhibit III-2, there are a series of ingredients to a successful productivity program. The top and last ingredient are the tools, or technology, that is applied. The straightforward implication of this simplistic recipe is that the tools and technology will only be successfully used if the other ingredients are in place. This conclusion has been reinforced by more recent research.

EXHIBIT III-2

**SYSTEMS DEVELOPMENT PROCESS
THE PRODUCTIVITY PYRAMID**

Right
Tools

Effective
Personnel

Broadbased
Management

End-User Involvement

Commitment to Quality
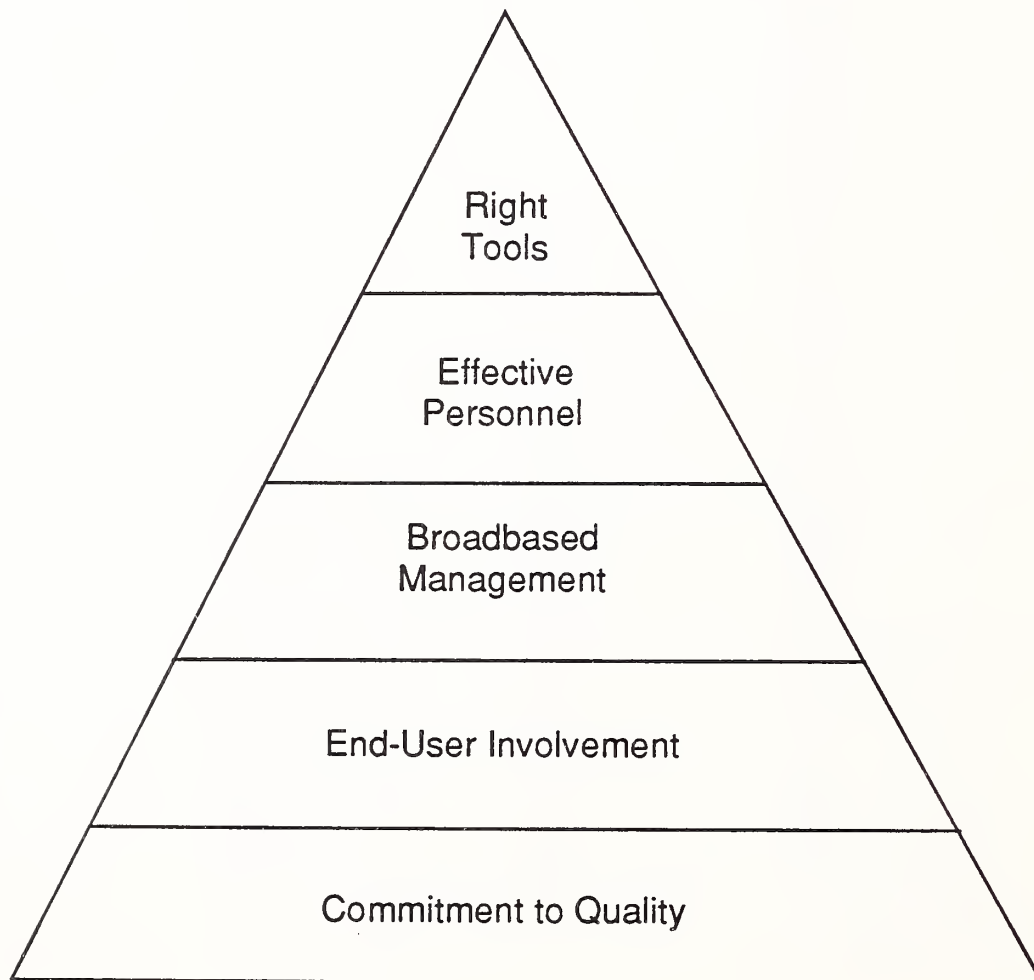
3. Systems Complexity

The continuing successful deployment of information technology and the never-ending creativity of software technology developers have unrelentlessly increased the complexity of the systems developed and used by today's organization. As Exhibit III-3 shows, the past 20 years have changed the orientation of the systems development challenge from one of creating a system that "processes data" to one that "integrates the system" into the strategic process of the organization.

EXHIBIT III-3

SYSTEMS DEVELOPMENT CHALLENGE
COMPLEXITY OF THE REQUIREMENT

Strategic Info Systems

Mission-Critical Systems

Distributed Processing

Interactive Systems

Applications

Data Processing Systems

Complexity

1970   1980   1990   2000
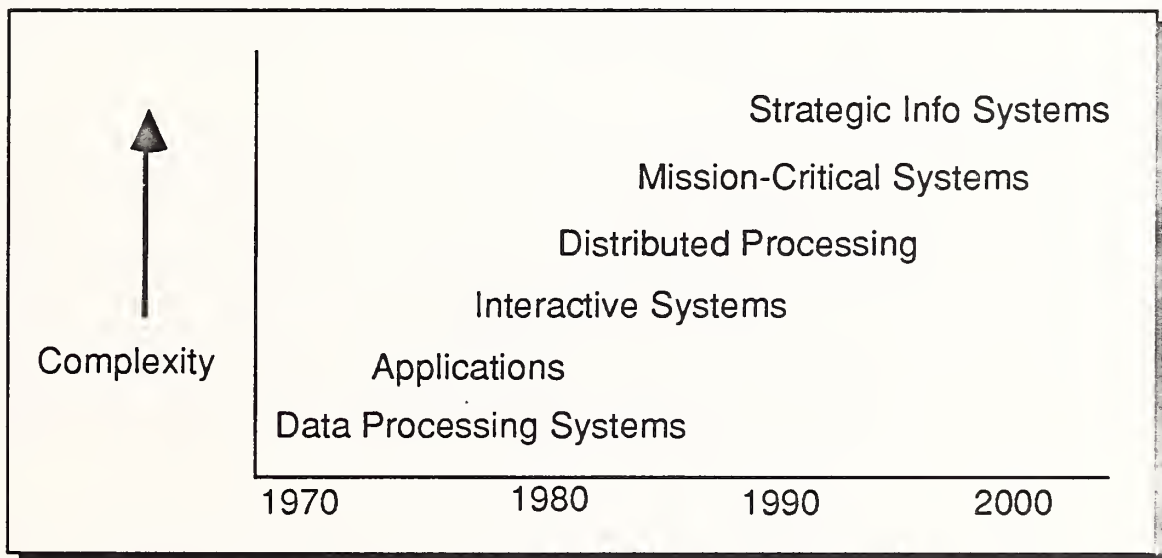
As the requirements have grown more complex, the name and the focus of what the systems development process is to achieve has changed. Each of these changes has complicated the development process at all phases of the life cycle and has often negatively affected the productivity of those involved.

In the 1986 report on software productivity, INPUT focused on the transition to distributed data processing, the introduction of new development technologies such as 4GL, RDBMS and the PC, and the early impacts of the end user's increasing involvement in the development arena.

- The entire distributed data processing evolution has added greatly to the complexity of current information networks and to the challenges that develop when a change in a distributed network must be implemented.

- Throughout the 1980s a series of application development tools (ADTs) were implemented. Each, while designed to increase productivity, brought with it a learning curve and numerous challenges and exposures. The decision by some companies to use 4GLs to develop major applications resulted in some of the most noted system failures of the mid-1980s.

- The cry to increase the involvement of the end user in the development process has existed since the early 1970s. By the mid 1980s user involvement had taken on a whole new character as users began to do their own thing with PCs, 4GLs, and departmental computing. The result has been progress, turmoil, and confusion relative to productivity improvements.

- Now systems integration is in vogue as the approach to achieve truly complex, highly integrated information systems that are true solutions to business problems. The complexity of many of the systems being addressed in the systems integration concept goes way beyond that experienced in the mid-1980s. These projects typically include the use of an outside systems integrator that holds ultimate responsibility for the project's success. We may learn that these external companies can bring the discipline required to meet the latest level of systems development complexity, and that they will do so through the use of CASE.

In essence the software productivity challenge has been a moving target driven by expanding user requirements and technology. It is important that the opportunity for CASE be viewed in this light.

At each step of the evolution of the systems development challenge one or more attempts have been made to improve (or at least maintain) the productivity of the development process. Results would indicate that success has been modest at best.

B

Current Application Development Environment

Today, the application development function of the large information systems organization faces an expanded challenge. This department of such an organization is saddled with huge investments in older technology, pushed to adopt and deploy new information technology, and operates in an environment that is becoming more strongly controlled by the end user. Routinely such departments face the challenge of doing more without additional resources, budget, or staff.

1. Software Crisis

It seems that every analyst of the information systems arena reports the existence of a software crisis. The demand for new systems is going unanswered, development backlogs are increasing, and the application software market is growing faster than the information services industry as a whole.

Exhibit III-4 provides a simplistic characterization of the software crisis. The focus of this crisis is applications software. The problem resides in where the requirements and the solutions collide—the user and the information systems professional. It is the in-house/applications software segment of the broader software arena where the requirement for productivity improvement is again gaining steam.

EXHIBIT III-4

SOFTWARE CRISIS

Software Development				
	In-House		Products	
	Small	Large	Small	Large
Systems Software				
	Small	Large	Small	Large
Applications Software				
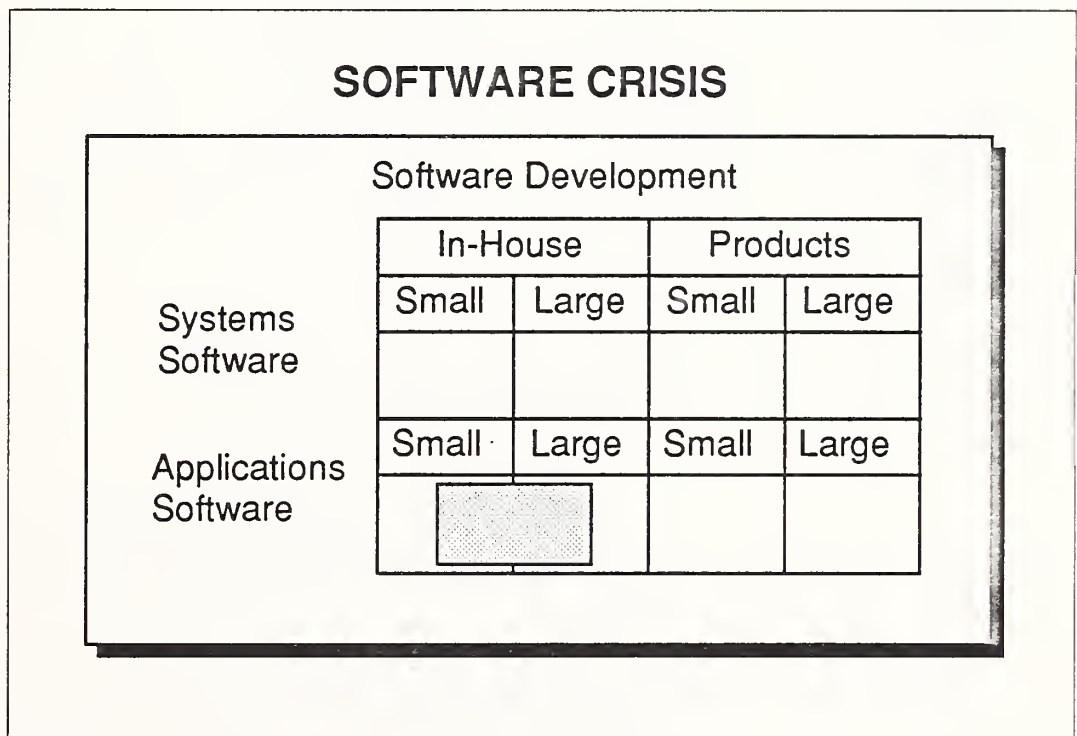
2. Application Development Demands

The demand for new applications goes on and on. The long-standing applications development backlog has become a fixture in the IS organization. As Exhibit III-5 shows, attempts to reduce the backlog through various technologies and methodologies has not succeeded. Between 1981 and 1986, 60% of those surveyed indicated the backlog had increased in spite of the use of 4GLs and other technologies. And in a 1988 survey INPUT found over 40% still indicating the backlog was still going up.

EXHIBIT III-5

24

APPLICATION DEVELOPMENT BACKLOG

Unchanged — 45 (1988 versus 1987), 25 (1986 versus 1981)

Increased — 43 (1988 versus 1987), 60 (1986 versus 1981)

Decreased — 12 (1988 versus 1987), 15 (1986 versus 1981)

Legend:
- ▨ 1988 versus 1987
- ▧ 1986 versus 1981

X-axis: 0 20 40 60 80 100

Percent of Respondents
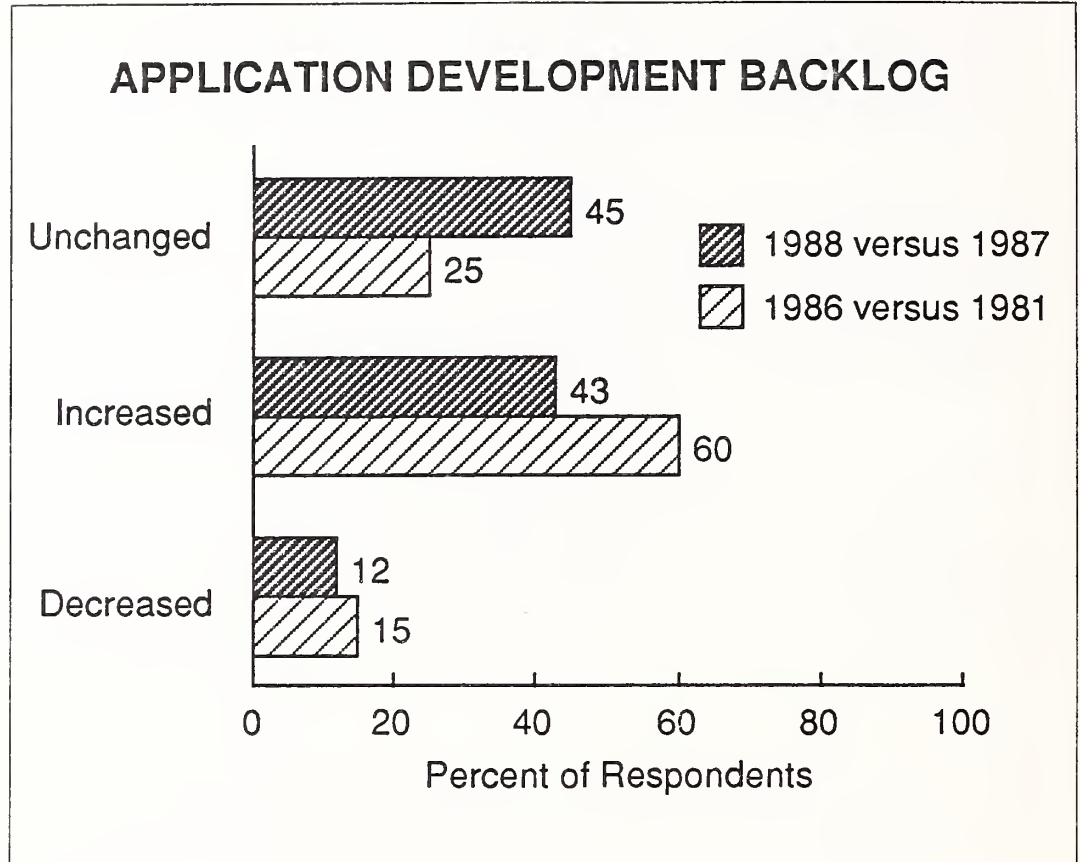
- Even more telling is the fact that only 15% in 1988 and 12% in 1986 indicated there was a decrease.

- In many IS organizations it has become common practice to simply limit the backlog to three years as a means of controlling it. Of course the result is the "hidden" backlog that today is being addressed by end users.

It is safe to conclude that the solution to the backlog phenomenon does not currently exist or at least is not in common use. The ability to create new uses for information technology continues to outstrip the ability to deploy it.

3. Application Maintenance

Today the most significant drain on the resources of every information systems organization is the maintenance and enhancement of the existing applications portfolio. In spite of all other challenges and priorities, the applications development function must give first priority to fixing problems with, and providing improvements to, the applications currently in use.

For years INPUT has asked information systems management to allocate
the applications development resources between developing new systems,
enhancing existing systems and maintaining existing systems. In recent
years the answers have become almost predictable. Exhibit III-6 pro-
vides the results of the 1987 and 1988 INPUT surveys of large IS organi-
zations.

EXHIBIT III-6

APPLICATION DEVELOPMENT
ALLOCATION OF INTERNAL RESOURCES
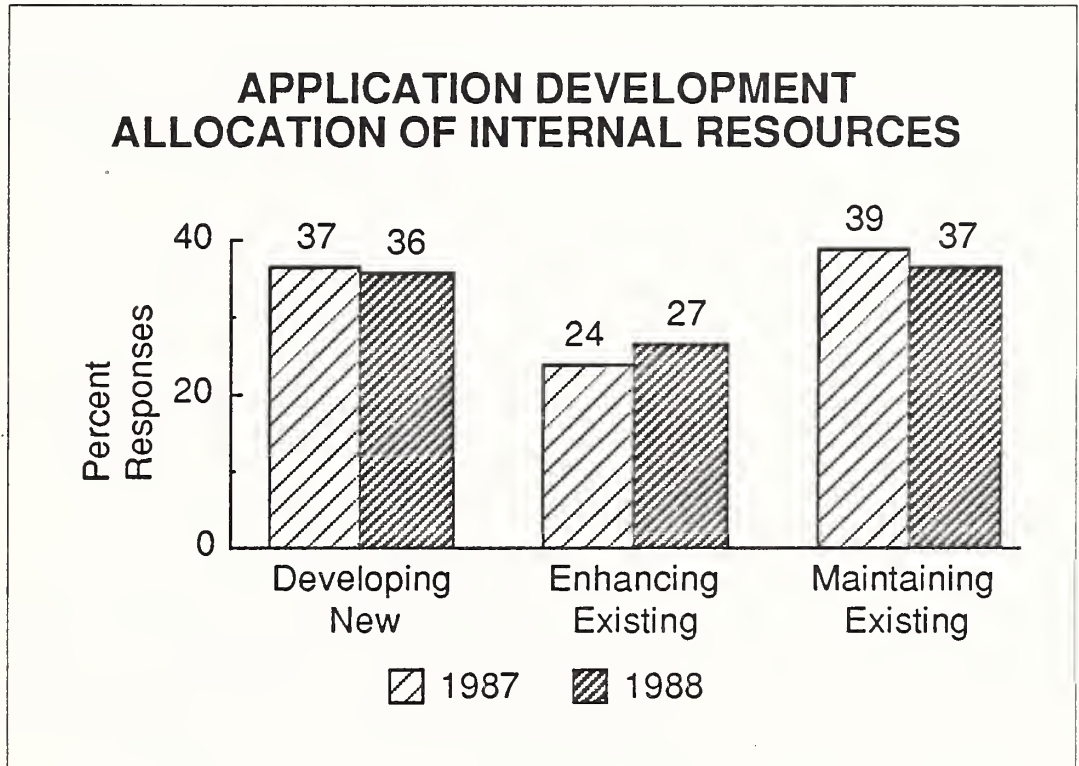
The results are very consistent. Essentially IS management has set a limit
of 60% to 70% of development resources being allocated to the current
applications with the remaining 30% to 40% percent allocated to new
development. Given that distribution, the applications development staff
goes about its job doing what it can. For productivity and CASE the
implication is that the challenge is two-thirds existing systems and one-
third new systems. While the latter is the easiest to address with CASE
technology, the former is the more critical problem.

The problems of doing maintenance are of course many fold. Exhibit
III-7 list four critical problems, all of which impact on the challenge of
productivity and the use of CASE in this most demanding part of the
application development life cycle.

• In spite of all of the "structured programming" stories and efforts of the
    1970s and 1980s each programmer's approach to coding is quite
    unique. Thus the first productivity inhibitor to the maintenance/en-
    hancement process is interpreting the code.

EXHIBIT III-7

APPLICATION MAINTENANCE
KEY PROBLEMS

- Programmers Must Understand Another Programmer's Code.

- Programmers Must Consider the Impacts of Their Changes on the Rest of the System.

- Changes Must Conform to the Overall Design of the System.

- Documentation is Usually Insufficient to Permit the Above.

- Once maintenance programmers think they understand the code they must assess the effects of the planned changes. For a fix this may be modest, but for an improvement to a complex DBMS application, the implications may prove to be complex and very difficult to identify.

- One of the truisms of the development process is under-documented programs, both in the code and in the written documentation. And if documention exists, it most certainly is out of date.

The implication is that each change requires a "start from scratch" approach to assure the change does not cause ripples throughout the system.

C
Addressing the Productivity Challenge

This chapter started with the observation that improving productivity in the systems development process has been a long-standing challenge. The efforts have been numerous and more remain to be tried.

- Each new generation of programming language has included productivity as a stated objective.

- The age of paper-based development methodologies has come and gone, providing only marginal benefits in most development functions.

- Fourth-generation languages have reached a high level of penetration with the benefits of productivity being balanced by negative impacts on computer utilization and the maintenance task.

- Other application development tools such as DBMS and application generators have helped meet the response for more complex, real-time systems; however, the productivity gains have been lost in the challenge to build the complicated application.

Both technology and management prowess have been applied, but none of the efforts to date has had lasting effect. The reasons include:

- The technology advances most often only addressed the later phases of the development life cycle. The easiest part of the job—programming—was improved; not the more time-consuming and error-prone tasks of analysis, specification, and design.

- The paper methodologies, both management and design and analysis, were not uniformly implemented and the required discipline was not employed. In too many instances the end reaction was that time was lost, not gained, through their use. The old mentality of "code first and design second" was not to be defeated by a paper-control system.

- The costs and shortcomings of the 4GLs and early application generators caused trepidation about their use on a broad basis. The many instances of 4GL-based major applications not living up to expectations suggest they can't replace COBOL in general use.

None of the prior attempts truly addressed the entire development life cycle nor did they provide the broad framework needed for lasting impact. Exhibit III-8 provides an assessment of where prior, current, and future application development tools are on the maturity/benefit curve. The question is whether the new generation of CASE tools and complete CASE systems will achieve lasting impact.

EXHIBIT III-8

SOFTWARE DEVELOPMENT APPROACHES—
LEVEL OF MATURITY

Maturity

DBMS

Manual
Methods

Program Development
Tools/Languages

CASE Tools

Complete CASE Systems

Artificial Intelligence

Object-
Oriented
Programming

Time
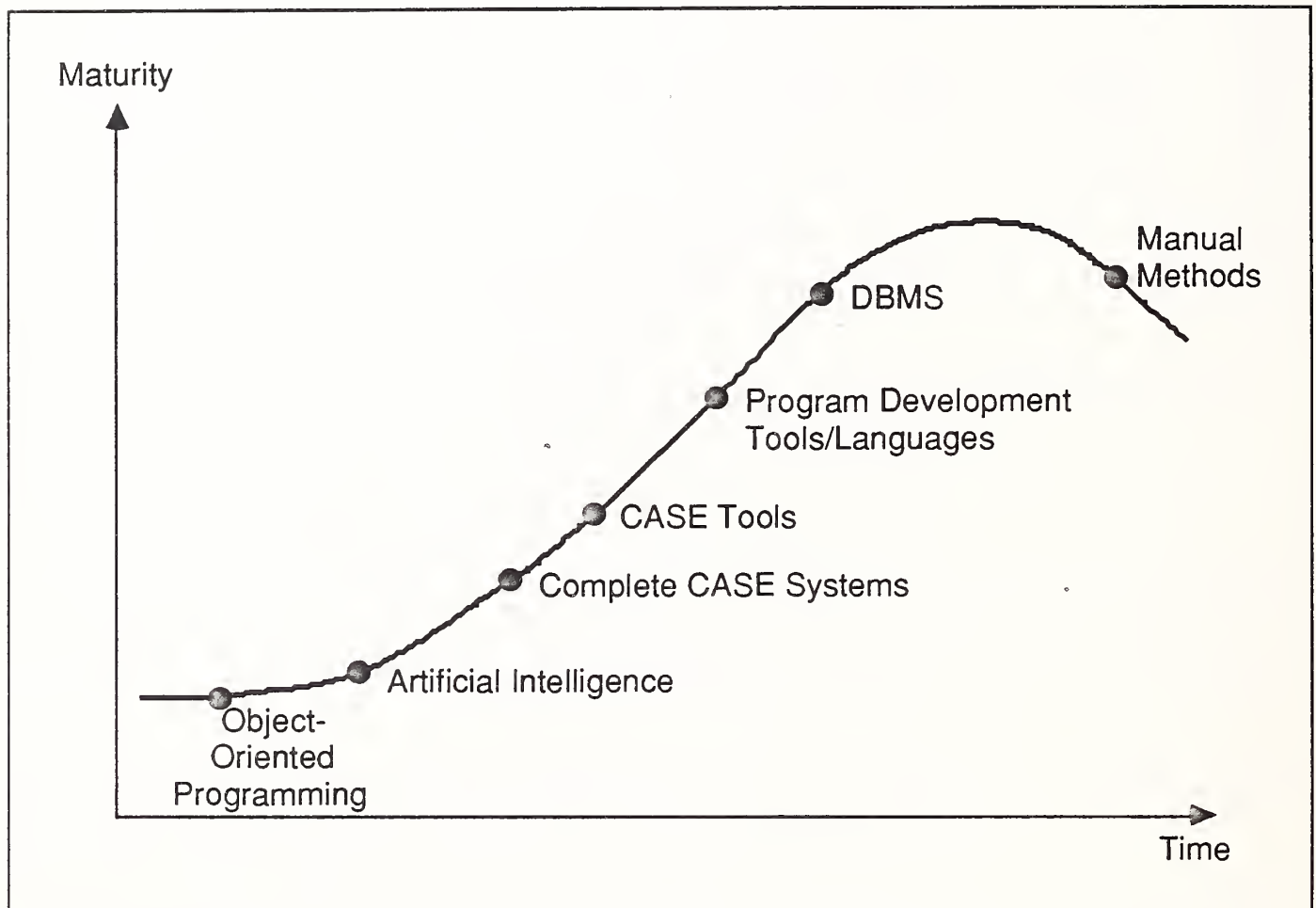
D

CASE Opportunity

Exhibit III-9 describes the true opportunity for CASE technology. It encompasses the entire development life cycle, all of the phases, the project management process, and maintenance and support. As one CASE tool vendor said, "as soon as the first application is developed using CASE technology you are in the maintenance business."

The goal of all improvements to the development life cycle have been to improve some phase of the cycle. With CASE the accepted challenge is, and must be, to improve all of the phases.

The improvement desired has two dimensions. First of course is productivity; second is quality. As discussed in Chapter V, today's application development manager links these two items directly. Just improving productivity is not enough and is often secondary. Improving quality often improves the success and life of a system, and probably improves the ease of maintenance.

The goals of CASE are to improve all aspects of the development process. As INPUT looks at the technology, describes the market as it is evolving, and probes the acceptance by CASE users, this broad, ultimate target will be the basis for this report's analysis.

EXHIBIT III-9

CASE OPPORTUNITY DEFINED— THE DEVELOPMENT LIFE CYCLE

Project Management

Requirements

Analysis

Functional Specification

Design Specification

Coding & Test

System Integration

Release & Acceptance

Application

Maintenance & Support

IV
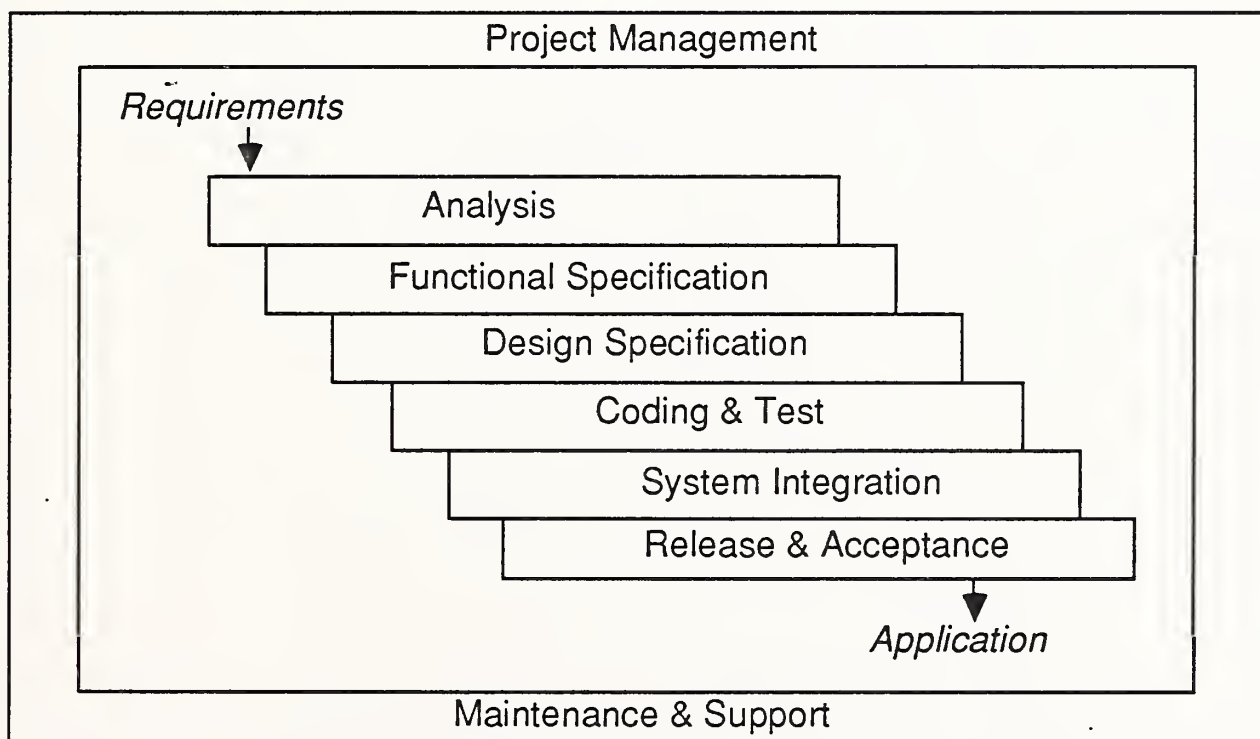
Market Analysis and Forecast
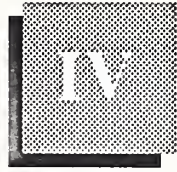
Market Analysis and Forecast

Chapter III provided a historic perspective on software productivity as the genesis for the CASE opportunity. In this chapter INPUT defines the market, analyzes the opportunity, and presents a five-year forecast.

A
CASE Technology

The use of the terminology *Computer-Aided Software Engineering* or *CASE* is still relatively new, having come into common use in 1987. CASE has its heritage in the CAD/CAE industry where the computer and its graphics capabilities brought a new environment to the task of product design. The mechanical, electrical, and architectural design processes have benefited from a graphics oriented computer based approach since the late 1970s.

For whatever reasons, it has taken until the mid 1980s for these efforts to begin to do the same for software and systems design. It took the common use of personal computer technology and the development of powerful workstation technology for CASE to attract significant attention and for a market to form.

The cause may be the one significant difference in engineering and systems development. The majority of engineering, whether electrical, mechanical, or structural, follows a set of well-documented and scientific principles, each of which can be described and applied through computer logic. There is no similar set of principles in the systems development process, in particular the specification and design phases. Thus the development of truly disciplined design tools and their full application will cause, within the systems development profession, a much greater cultural change than in the engineering professions.

1. Categories of CASE Tools

The components of a CASE technology are simplistically diagramed in Exhibit IV-1. The principle components are in support of new development.

EXHIBIT IV-1

CASE—A BASIC FRAMEWORK

New Development

Life Cycle Management		Maintenance
Design	Code Generation	Translators Analyzers Comparators Restructurers
Documentation		
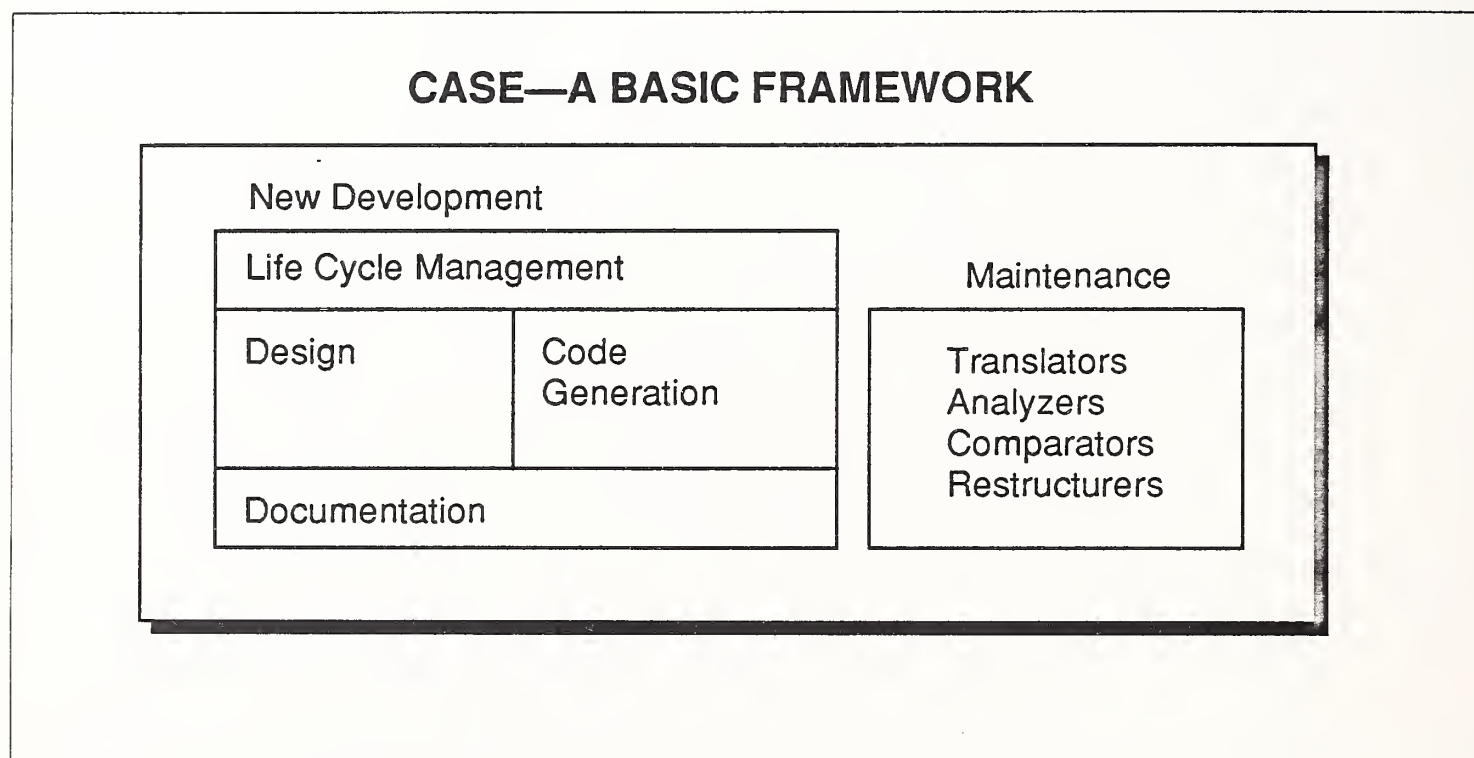
The subcategories of products in the new develop sector are:

• Life Cycle Management—Tools, usually personal computer-based that control the scheduling and project management process and are linked to the design tools.

• Design—PC-based, graphics-oriented tools that structure the specification, design, and data base specification process. In their full sense they develop a systems specification (program and data base specs) that can be sent to a code generator for program creation.

• Code Generation—In its pure definition, a system that takes program specifications and generates, with minimal human intervention, the programs and data base definitions for the application. The end result is COBOL, or the appropriate code. Code generators are typically mainframe-based, but increasingly, elements of the product are being transferred to the workstation.

- Documentation—Each of these categories is intended to automate the documentation process so that consistent and concise documentation is provided to simplify the maintenance and enhancement process.

There also exists a collection of maintenance tools that address individual tasks. Some major design type tools to support the system re-engineering process are emerging. The more specific maintenance tools are not included in this study, but the re-engineering tools of Bachman Systems and others are discussed.

CASE is typically characterized as having two basic components. They are referred to as either front- or back-end CASE tools or upper and lower CASE tools. We will use front- and back-end terminology in this report.

- Front-end or upper CASE design and modeling tools have evolved through the use of graphics-based workstation and personal computer technology.

- Back-end or lower CASE code generation tools have evolved from the ongoing process to strive for higher-level programming languages and the implied productivity improvement and are usually central processor-based.

As these design tools have evolved, the logical effort to interface them so the computer- recorded design description can be translated by the code generation tool directly into computer executable logic has evolved. Successfully deployed, the front-end tools will improve:

- The quality, and perhaps the productivity, of the specification and design process

- The productivity, maintainability, and perhaps the quality, of the programming and data base specification process

2. CASE Evolution

Exhibit IV-2 pictures the evolution of the applications development tool arena. It helps place CASE technology in perspective relative to the other technology-based efforts to improve the development process. As is implied, a complete CASE system will draw on all aspects of existing and future development technology.

Exhibit IV-3 provides a schematic of a complete CASE system, often referred to as I-CASE where the CASE environment addresses the entire life cycle on an integrated basis.

EXHIBIT IV-2

APPLICATIONS DEVELOPMENT TOOLS (ADTs)— MARKET STRUCTURE AND EVOLUTION

Application Development Tools
(ADTs)

DBMS	Program Development Tools (PDT)	Languages	CASE Tools/ Tool Kits

- DBMS

- Data
  Dictionaries

- Application
  Generators

- Documentation
  Generators

- 4 GLs

- Assemblers/
  Compilers

- Methodology
  Companions

- Tool Kits

Complete
CASE
Systems

- Workbenches

- IPSEs
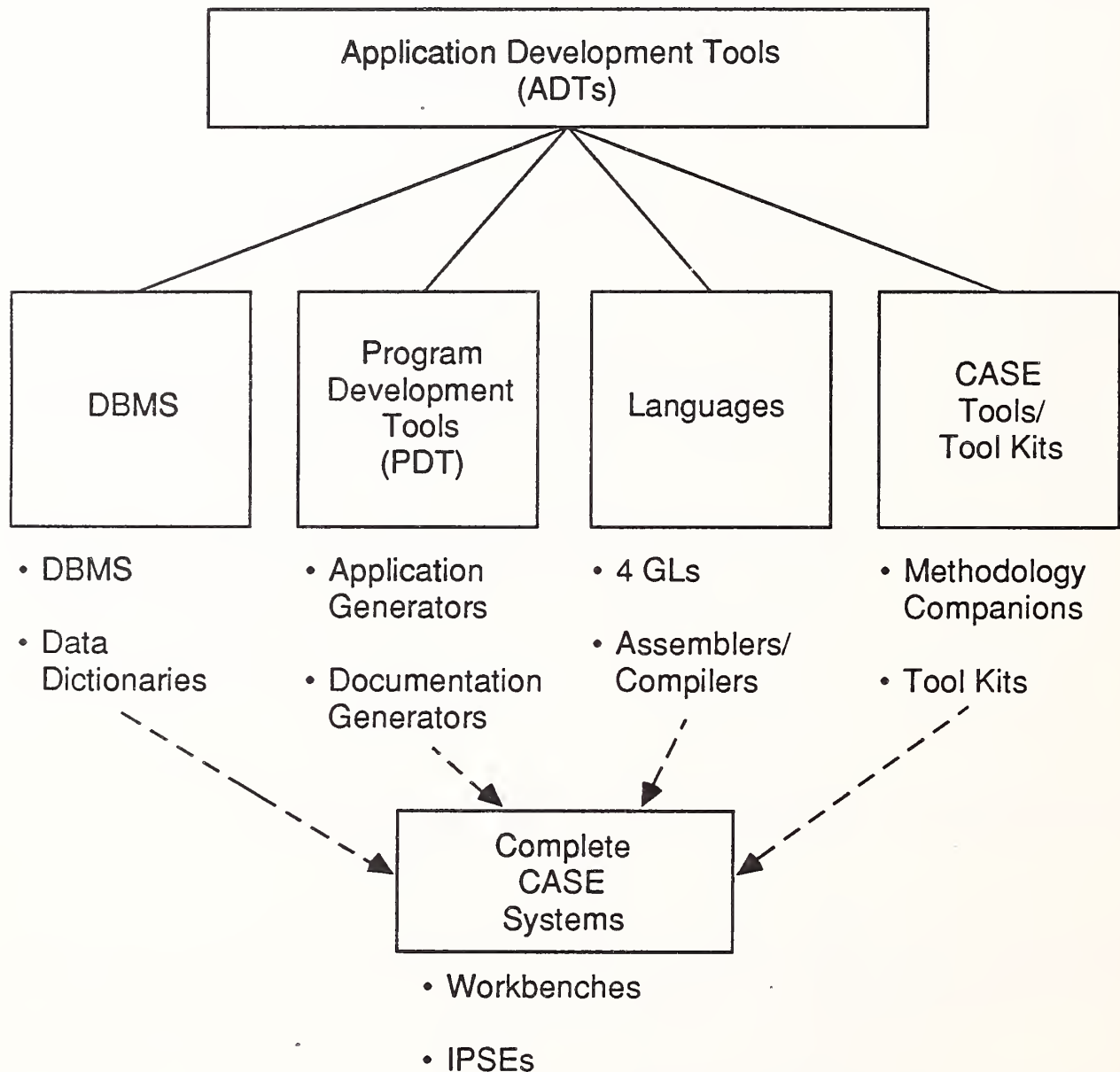
EXHIBIT IV-3

COMPLETE CASE SYSTEM—SCHEMATIC

Project Management

```
                    ┌──────────────────┐
                    │   Diagramming    │
                    │       and        │──────────┐
                    │  Specification   │          │
          ┌────────▶│      Tools       │          │
          │         └──────────────────┘          │
          │                  │                     │
          │                  ▼                     │     ┌──────────────────┐
  ┌───────────────┐ ┌──────────────────┐          │     │                  │
  │               │ │      Design      │          │     │    Automated     │
  │   Graphics    │─│    Analyzer/     │──────────┼─────│   Repository     │
  │    Screen     │ │     Checker      │          │     │                  │
  │               │ └──────────────────┘          │     │  Functions,      │
  └───────────────┘          │                     │     │  Processes,      │
          │                  ▼                     │     │  Procedures,     │
          │         ┌──────────────────┐          │     │  Data Models,    │
          │         │      Code        │          │     │  Process Models, │
          └────────▶│    Generator     │──────────┘     │  Business Models,│
                    └──────────────────┘                │  Data Dictionary │
                                                        └──────────────────┘
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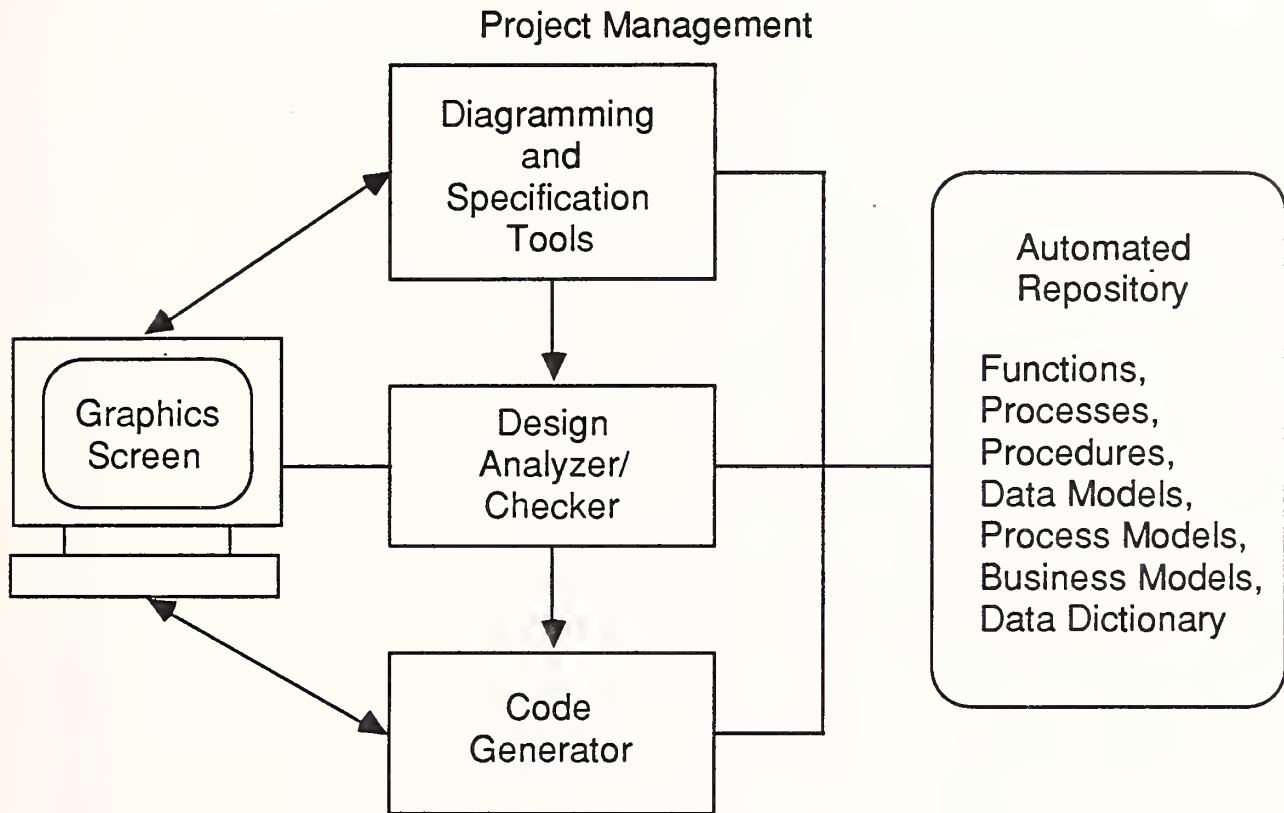
Included are a graphics-based user interface, a set of design and specification tools, tools that analyze and verify logic of a design, a code generator, and a repository that tracks and controls the design and resulting program modules.

It is the repository that will differentiate CASE from other previous technology advances in the development process. The structured repository goes well beyond the traditional data dictionary that is implemented in support of most data base management systems. It records all of the relationships, logic, processes, data models, and more. And it will be the source of reuseable code that in time may prove to be the largest contributor to productivity.

All of this is surrounded by a project life cycle management system.

3. CASE Tool Advantages

The advantages of CASE are numerous and are worthy of brief mention. Exhibit IV-4 provides a comprehensive list.

CASE TOOL ADVANTAGES

Design Process

- Assist in Project Management

- Assist in Design Specification

- Improve Documentation

- Assist in Data Modeling

- **Enforce Development Standards**

Programming Process

- Assist in Development of Code

- Assist in Development of Test Cases

- Assist in Debugging

- Assist in System Release

- **Assist in Maintenance**
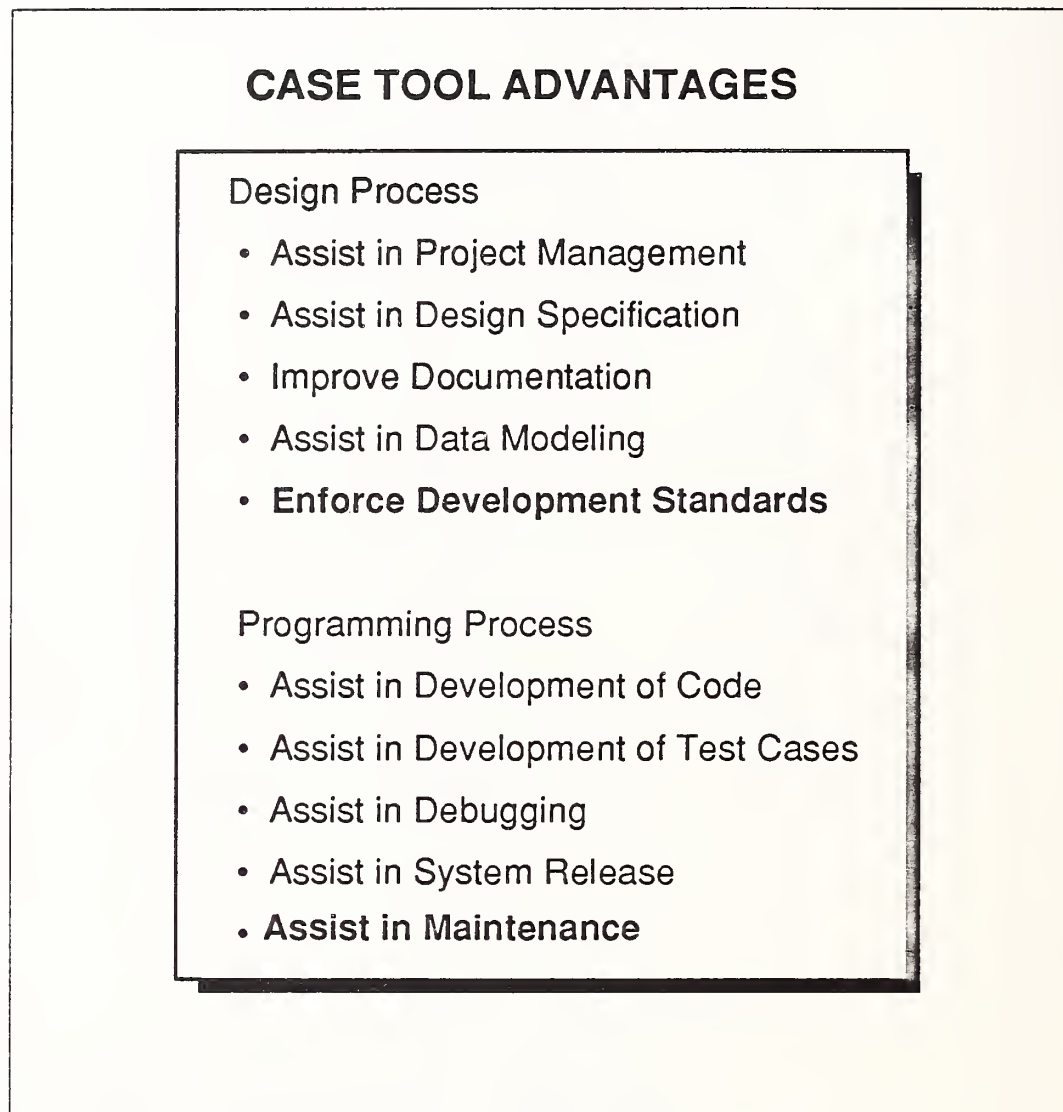
Two of these are the true essence of the value that CASE is intended to provide and are the justification for proceeding.

- **Enforce Development Standards**—Success with CASE mandates that discipline be added to the systems development culture. Thus the CASE tools, in particular front-end tools, must facilitate the discipline process. They must make it happen despite the natural resistance of the systems development profession.

- **Assist in Maintenance**—As soon as the first application is completed using CASE tools it will need enhancement. If the CASE design tool does not facilitate the change it is not providing the required value and will soon be discarded. IS will return to the historic pattern of not documenting the changes it makes.

4. CASE Technology Trends

When talking to today's leading CASE vendors three messages become quite clear concerning product direction.

- First, the push will remain workstation-oriented. As the power of the workstation grows and the use of CASE technology, including code generators, becomes ever more graphical in its orientation, the workstation will become the primary hardware for the systems development process. (This has been the evolution of the CAD/CAE technology).

- Second, I-CASE will become the byline of the industry. Vendors that cannot underwrite this direction will be acquired or become lower-tier competitors. As a result, the code generation and repository aspects of the complete CASE system, as diagramed in Exhibit IV-3, will take on greater importance. The technology will drive toward much higher integration between the design and code generation tools, an area where much development remains to be done.

- Third, the existing CASE technology, in particular the front-end tools, require another major step forward in terms of ease of use before the end user will be able to take advantage of CASE. INPUT is confident that by the early 1990s the end user will be producing close to half of the applications and certainly the majority of the input/output portion of applications. If the data bases and fundamental logic is done through CASE it will be essential that the portion developed by the end user be done in the same fashion. Therefore, front-end tool developers need to address the next generation of CASE interface environments soon to help guarantee continued market penetration.

The role of the repository in CASE remains relatively undefined and certainly underdeveloped. The majority of the CASE environments do not include a true repository and IBM has muddied the water by indicating that it is developing one, but not saying what or when. The Maestro I-CASE product from Softlab includes a repository that, along with others, is setting a starting point for the definition of the repository concept.

- In the long term the bet is that the repository, interfacing to the design, code generation, and data base management system will be the focal point of the development process.

- In the short term, the uncertainty about repositories can be expected to give some IS organizations another reason to delay the CASE adventure.

CASE technology is testing the abilities to apply technology to the systems development process and the willingness of the user to change. However, progress remains embryonic. The cost of attainment will be very high and many of the firms in the industry may not have the wherewithal to meet the required investment.

The workstation will take on an ever-increasing role in CASE technology.

- It is the principle interface to the front-end tools and can serve as the interface to most back-end products.

- Graphics will play an ever-increasing role in CASE technology, in particular as the interface is evolved for the end user.

- As the power of the workstation grows, more and more of the development process will be moved to that tier of the network, with only the repository residing at the central repository.

- One product, Maestro, already has moved in this direction by using a three-tier architecture. The code generator and the repository are on a departmental computer that serves a number of developers, thus tying their work on a single development project. A workstation is used by each developer for its individual activities.

B
Market Overview

1. Market Structure

The CASE market can be segmented into three major sectors as shown in Exhibit IV-5. They are:

- Information Systems Application Development—The traditional IS organization that supports a corporation or other organization. This market is the best recognized and easily the largest.

- Commercial Software Development—Organizations that develop software products for sale to others.

- Real-Time Systems—The development of imbedded software that becomes part of a higher-order product. A prime example would be the use of CASE on specialized systems in the aerospace industry.

EXHIBIT IV-5

CASE MARKET STRUCTURE

```
                    ┌──────────────┐
                    │    CASE      │
                    │   Market     │
                    └──────┬───────┘
          ┌────────────────┼────────────────┐
  ┌───────────────┐ ┌──────────────┐ ┌──────────────┐
  │  Information  │ │  Commercial  │ │  Real-Time   │
  │    Systems    │ │   Software   │ │   Systems    │
  │  Development  │ │   Products   │ │              │
  └───────────────┘ └──────────────┘ └──────────────┘
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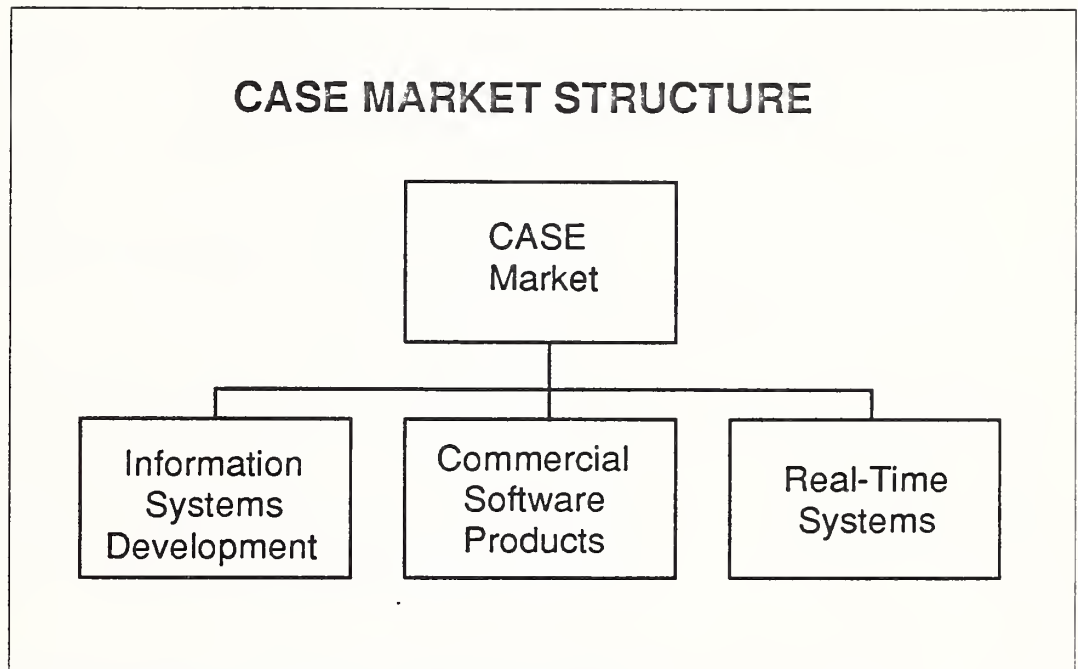
The primary focus of this chapter and the market forecast is the Information Systems Application Development segment. This segment was identified in Chapter III as the focus of the software crisis. Furthermore, it is the largest sector, and is the focal point of the majority of the leading vendors.

2. Vendor Categories

CASE vendors are approaching the market from a number of viewpoints. CASE vendors can be categorized as shown in Exhibit IV-6.

EXHIBIT IV-6

CASE VENDOR CATEGORIES

- CASE Tool Developers: Developers and Marketers of CASE Software Tools, Either Front End, Back End, or Both.

- Methodology-Based Vendors: Developers and Marketers of CASE Software Tools Where the Tools Are Based on a Specific Development Methodology.

- DBMS and 4GL Vendors: Developers of Application Development Tools That Are Adding CASE to Their Proprietary Product Line.

a. CASE Tool Developers

- The CASE tool developers are, for the most part, independent companies that have developed a unique technology. There are two varieties.

  - Those that develop and market either front-end tools (Index Technology and Nastec) that are principally PC-based; or back-end tools that are mainframe-based (Sage Software).

  - Those that have, through internal development or acquisition, a full I-CASE product covering front- and back-end technology (Texas Instruments, Softlab, and KnowledgeWare).

- Many of these companies evolved from an earlier business basis, in particular, custom systems development. Examples are Index Technology, Softlab, and Sage Software.

- The exceptions would be companies like Texas Instruments and McDonnell Douglas where their entry into the CASE market can be tied originally to internal systems development needs.

b. Methodology-Based Companies

- Professional Services companies have long used disciplined systems development methodologies. In Arthur Andersen's case, it turned its methodology into a product, and is computerizing all aspects of it.

- Other professional services companies such as Arthur Young and Deloitte Haskins & Sells have joined with CASE tool vendors to merge their methodologies with the vendors tools. An example is Deloitte Haskins & Sells banding together with Holland Systems.

- Other companies such as Holland Systems, Bachman, and Yourdon have entered the CASE market based on their own very specific systems management and development philosophies. They have a "religion" that they are propagating through computer-based tools.

c. DBMS/4GL-Based Companies

- Quite naturally, the long-standing and emerging developers of DBMS and 4GL technology see an opportunity and a need to participate in the CASE market. In order to stay competitive, they must move their technology up to the design process and to enter the code generation arena.

- Examples include Cullinet, which has acquired rights to a product and is adapting it to IDMS; Oracle, which is developing its own CASE

front end; and Pansophic, which developed the code generator Telon and is using it to broaden its role in the application development arena.

Exhibit IV-7 categorizes the leading and commonly mentioned CASE vendors.

EXHIBIT IV-7

CASE VENDOR—EXAMPLES

Tool Developers	Methodology-Based	DBMS- and 4GL-Based
KnowledgeWare	Arthur Andersen	Pansophic
Index Technology	Yourdon	Oracle
Nastec	Bachman Systems	Cullinet
Sage Software	Holland Systems	
Texas Instruments		
McDonnell Douglas		
Softlab		

3. Vendor Strategies

The strategies being deployed in the CASE market are as diverse as the players. While this may be typical of any emerging software market, the breadth and scope of CASE over the long term suggests a level of complexity that will prove to be unique looking back in five years, when the market and technology will have matured.

• The players range from a fixed methodology for information resource management to looking through the back door to re-engineer the existing applications and data base architectures. If you believe, as the spiritual leader of the specific leader believes, then you must use their and only their tools.

• One front-end tool developer simply says a methodology must be in place. He claims his company's tools will adapt to the methodology, strengthen it, and improve the productivity and quality of system designs.

- And then there is the I-CASE vendor that brings the entire life cycle support system. His pitch is that the real gain is in the integration of the CASE tools, not the use of individual tools.

In essence, CASE is a young market with a variety of vendors searching for a strategy that works. It may be that the vendor that gets there first with a reasonable solution will be the winner.

Another element of most CASE vendor strategies is the use of alliances. Today the market is full of alliances (real and temporary) that are designed to outposition the next firm and to make most firms appear as I-CASE vendors. These alliances are analyzed in Chapter VI. INPUT expects them to play a major role in the future shape of the market as they either disappear or become permanent in the form of acquisitions and mergers.

C
Market Forecast

1. Forecast Definition

The forecast and market analysis that follows focuses on the Information Systems Application Development segment of the CASE market as defined in Exhibit IV-5, and the vendors that have chosen this sector as their primary market. Of necessity, it includes some vendors that entered the market in the real-time systems area and are now active in both arenas.

The forecast includes both front- and back-end products and vendors, although it must be noted that the code generation segment is less easily defined. The application or code generator products have some overlap with the more traditional 4GL area.

Exhibit IV-8 provides a framework for the forecast. Training and support services are believed to be a major factor in the future growth of this market and are discussed below in the section on delivery mode.

EXHIBIT IV-8

CASE SOFTWARE AND SERVICES
FORECAST DEFINITION

Type of Product \ Mode of Delivery	Software Products	Professional Services - Consultancy - Education and Training	Standard Turnkey Systems
Advanced CASE Tools	Integrated Project Support Environments (IPSE'S)		
	Workbenches—Analyst/Programmer Integrated Environments		
Basic CASE Tools	Individual Tools or Workbenches Supporting a Limited Range of Phases of the Development Life Cycle i.e.: • Project, Quality, and Implementation Management • Design and Analysis Tools • Specification Tools • Prototyping Tools/Testing Tools • Configuration Management Tools • Maintenance (Retrofit) Tools • AI Tools		
Other	• Application Generators		
Application Development Tools (ADTs)	• Languages (e.g. 4GLs) • DBMS • Data Dictionaries—Screen Painters • Compilers—Assemblers • Retrieval Systems • Static and Dynamic Analyzers		

▓▓▓▓▓▓▓▓▓ Boundary of INPUT's Market Definition for Specialist CASE Tools, Products and Services.

2. Market Size

a. Market Forecast

INPUT's analysis shows that the CASE market has been growing close to 100% per year in the 1985 through 1987 period. Exhibit IV-9 sizes the U.S. market for 1987 at $125 million with a distribution between front-end tools, back-end tools, and professional services.

EXHIBIT IV-9

**CASE MARKET SIZE
1987 U.S. REVENUES**

Professional
Services
15%
($19)

Back End
25%
($31)

Front End
60%
($75)

$ Millions

Total = $125 Million
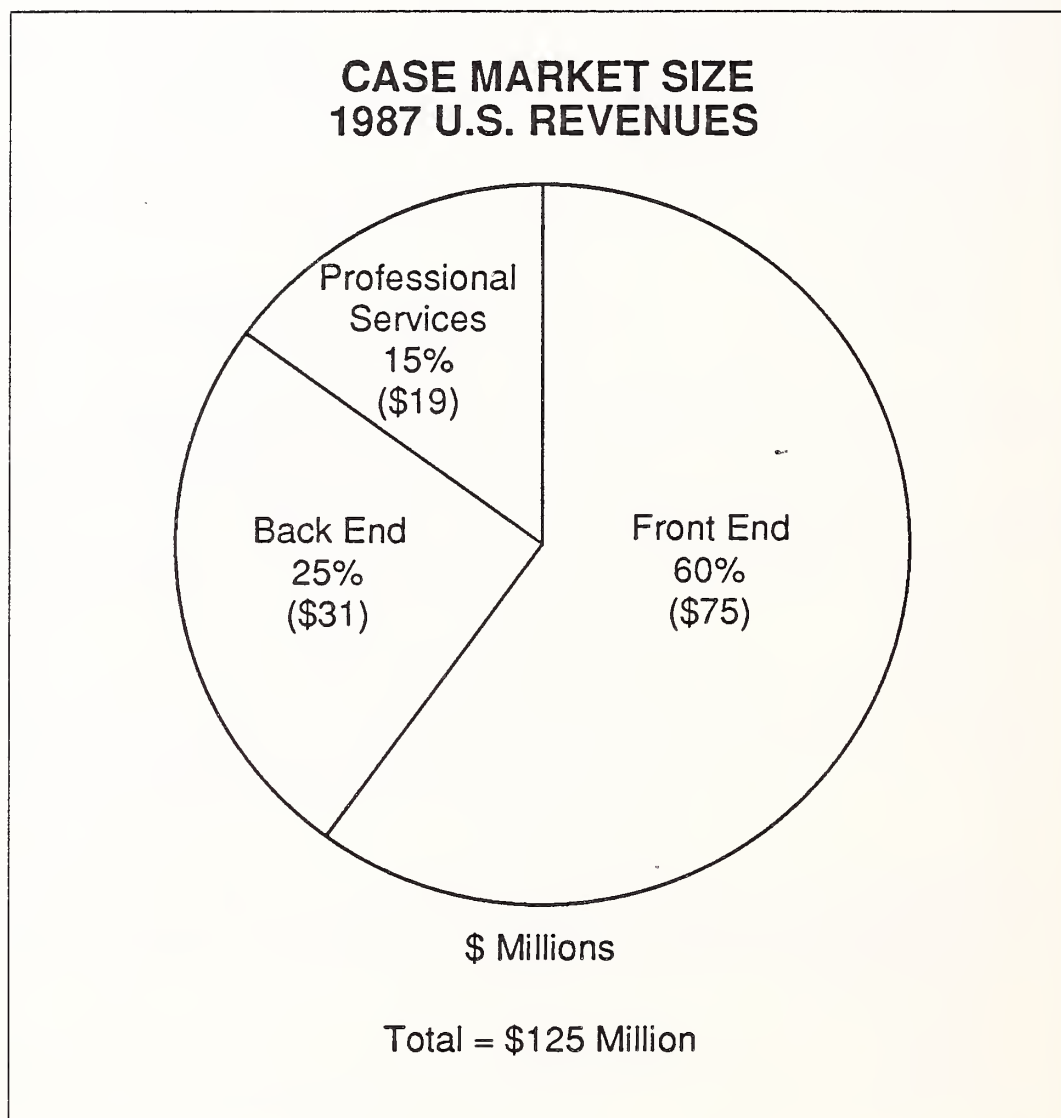
- Currently the front-end segment is dominant with at least 60% of the total market and two-thirds of the product sales.

- The back-end product segment, with its higher entry price and smaller number of vendors, is logically developing at a slower pace and represents approximately 25% of the total market today.

• The professional services segment consists predominantly of training and education versus consulting at this point. The 15% size is, interestingly, much smaller than for the European CASE market that INPUT forecast in 1987. In that market the professional services activity approaches 30% of the total market. In the near term INPUT expects this activity will grow in the U.S. market as well.

Exhibit IV-10 provides INPUT's five-year forecast for the U.S. CASE market. In 1988 the market will grow to $215 million, almost double the 1987 level of $125 million. And by 1993 the market will reach $1.42 billion. The 1988 to 1993 compound average growth rate (CAGR) will be 46%.

EXHIBIT IV-10

CASE MARKET FORECAST
U.S. REVENUES—1988-1993
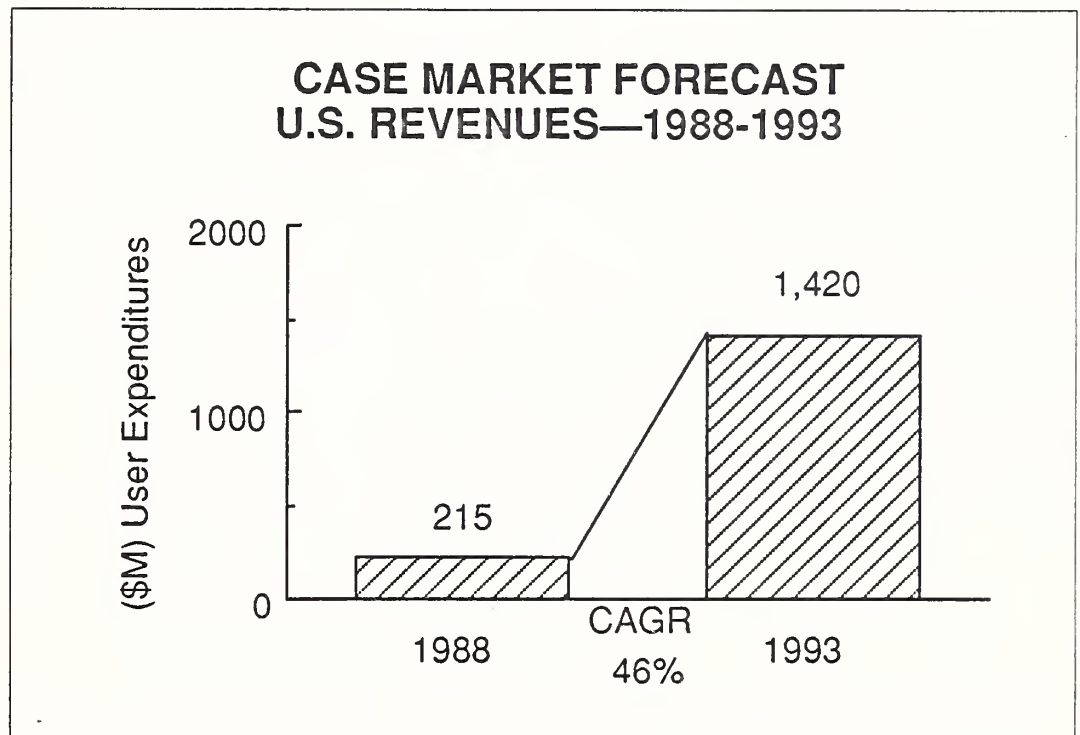
b. Market Growth by Delivery Mode

Exhibit IV-11 provides a five-year forecast by delivery mode.

The front-end products will lead the market. They have lower entry costs, are workstation based, and are an easier decision for management.

• The front-end market is at best 5% penetrated at this point. Assuming that the 1987 sales level of $75 million equates to a 2.5% penetration, the market would approach a 60% to 70% penetration level at the end of 1993 with a revenue level of $1,050 million.

EXHIBIT IV-11

CASE MARKET FORECAST—U.S. REVENUES
BY DELIVERY MODE
1988-1993

Delivery Mode	1987 $M	1988 $M	1987-1988 Growth (Percent)	1993 $M	1988-1993 CAGR
Software Products					
Front End	75	135	80	1,050	51
Back End	31	45	40	230	40
Professional Services					
Training/Education	13	23	80	85	30
Consulting	6	12	100	55	36
Total	125	215	72	1,420	46

- The market has not shown any price resistance at this point. A leading I-CASE vendor raised its prices 15% on all products in the third quarter 1988 and has found no negative reaction. It is likely that prices will increase slowly over the next few years, further supporting the growth rate.

- Over the five-year period the front-end sector will have a CAGR of 51%.

The back-end products market is affected by a longer decision cycle, a larger initial investment by the buyer, and a greater technological impact.

- The market will grow from $43 million in 1988 to $230 million in 1993. Over the five-year period the CAGR will be 40%.

- The market is less developed at this point, with fewer vendors.

- The market is less developed at this point, with fewer vendors.

- This product sector also reflects a smaller total market potential. It is site based, not workstation based.

The professional services market includes Training and Education and Consulting.

- The Training and Education sector is becoming developed through the efforts of the more-established vendors. INPUT estimates it represents about 10% of the overall market and will conservatively grow to $85 million. This forecast primarily reflects the training efforts of the CAE vendors themselves and that of major information technology vendors such as Applied Learning International.

- The Consulting sector of the CASE market is not well developed at this point. The leading software products vendors, with very few exceptions, are not actively pursuing the market at this point.

  - INPUT believes that professional services companies can contribute a great deal to guiding information systems through the cultural aspects of CASE implementation.

  - The market is conservatively sized at $12 million in 1988 growing to $55 million by 1993. It is likely that a lot of CASE-related consulting will be performed in conjunction with other professional services activity, particularly systems integration projects.

c. Beyond 1993

The next five years will bring a significant level of maturity to the CASE market. However, CASE technology and the market will enter the mid-1990s with significant opportunities.

- The technology will go through significant evolution at the workstation and code generation points, particularly in the integration of front and back end.

- The end users will be a major development resource and participant by 1993 and will be looking for CASE tools that they can use.

The front-end market is expected to go through a two-phased evolution.

- The first phase relates to the information systems professional with this segment maturing in the middle of the decade. After this happens, it will grow on added features versus penetration and major new products.

- The second phase relates to the use of CASE by the end user. INPUT believes that this usage offers a market of equal or greater size than the current concentration on the IS professional. It will require major advancements in the user interface and level of integration, but INPUT believes these are achievable. By 1993 this segment of the market will exist and will carry through the end of the decade.

The back-end market is developing more slowly. The penetration rate will lag behind the front-end sector and will still have a steady growth opportunity after 1993.

3. Market Pressures

a. CASE and IS

The growth of the CASE market will soon be tied directly to the rate with which the information systems organization and the systems development function is ready to change.

- To date the early penetration, which is about 5%, can be tied to experimentation and prototyping. Certainly there remain many organizations, perhaps three out of four, that are not even at this level. Many of these are the overly cautious IS function that may be a number of years from truly trying CASE.

- The key challenge will soon become moving the experimenters into real use.

Some of the factors that will impact the willingness of IS departments to move forward with CASE include the following.

- The increasing role of the professional services firm in the development process—As more systems integration and custom development projects go outside to firms that use CASE as a means to make a profit, the IS organization will begin to have CASE demonstrated. Once the system is delivered it may well come with the CASE technology that was used to develop it. The result will be IS inheriting one or more CASE tools.

- The availability of re-engineering and other support tools for existing applications will gain attention from the IS staff struggling with the maintenance challenge. Since this takes two-thirds of the development resources, there is much to gain. A number of older applications will soon undergo major modifications to fit into information architectures of the 1990s using relational data base technology.

- Success with CASE, of course, requires training. The number of true experts that can serve as teachers will be a restriction. Many vendors are just beginning to give real attention to their training programs, let alone true consulting services. If these support services are not strong they may prove to be the greatest deterrents to growth in the next few years.

b. CASE and the Professional Services Sector

The role of the professional services sector of the industry regarding use of CASE is very significant. Their success, or lack thereof, will have a major impact on the market growth rate over the next few years.

- Almost every front-end tool developer is aligned with the management consulting practice of a major accounting firm.

- A number of accounting firms are actively supporting a CASE partners product development and marketing, or are developing their own CASE line of products.

- Professional services companies have the need and ability to attack the total spectrum of the productivity challenge. Often, these firms can more quickly impact the internal culture as required to set up CASE.

- The movement to the systems integration concept for providing professional services will increase the pressure to use CASE to assure large, complex systems are successful.

c. I-CASE and Technology Developments

- The pressure to respond to the growing need for a complete integrated CASE product are beginning to pressure the independent CASE vendors to consider development through acquisition and merger versus internal development.

- The cost of the CASE environment of the mid-1990s is likely to be beyond the resources of most independent companies.

d. The Role of Alliances

The emergence of the CASE software market has brought with it a seemingly unique and significantly active alliance process. Unlike other major software markets, such as data base management systems, it seems that every CASE product vendor has some type of alliance(s). Examples include:

- Front-end companies (such as Index Technology) aligning with back-end companies (such as Pansophic and its Telon code generator) to permit the sale of a total CASE system.

- Each of the front-end companies has some type of alliance with a consulting or major accounting firm that uses its design tools.

- Design tool developers have aligned with software developers (e.g., DBMS companies) and others in an OEM distribution relationship.

Exhibit IV-12 identifies the types of existing alliances, and those being formed. In Chapter VI, Competitive Environment, INPUT identifies many of the alliances and analyzes the implications for the strategies of the individual vendors.

EXHIBIT IV-12

CASE MARKET ALLIANCES

Types of Alliances
Front End/Back End and Vice Versa: Firms Agreeing to Interface Their Products to Suggest a More Complete Capability
Professional Services/Tool Vendor: A Professional Services Firm Selects a Single Vendor's Tools, Participates in the Development, and Uses Them with Its Clients
Life Cycle Alliances: Using Multiple Alliances to Represent an I-CASE Capability
CASE Vendor/OEM: CASE Vendor Seeks Marketing Partners

As the market begins to emerge, it is expected that many of these alliances will either disappear or turn far more serious. Today most of them are engagements. Those that last may become mergers.

4. Market Share

The CASE market is without a dominant leader. None of the hardware firms are providers of mainline CASE products and the major software

companies are not dominant players, with the exception of Pansophic with Telon. The leaders are, in fact, start-up independents.

- Index Technology with its Excelerator Product Line
- KnowledgeWare with IEW and GAMMA
- Nastec with CASE2000
- Cadre Technologies with Teamwork
- Sage Software with APS

Exhibit IV-13 provides a market share analysis based on 1987 U.S. sales and INPUT's estimate of the entire market at $125 million.

EXHIBIT IV-13

CASE MARKET LEADERS
1987 ESTIMATED REVENUES

Company	U.S. Revenues ($ Millions)	Market Shares (Percent)
Index Technology	18	14
KnowledgeWare	11	9
Sage Software	10	8
Nastec	10	8
Pansophic	8	6
Cadre Technology	6	5
Texas Instruments	5	4
Cortex	4	4
Language Technology	4	3
Softlab	2	1
Others	47	38
Total	125	100

V
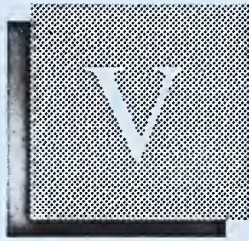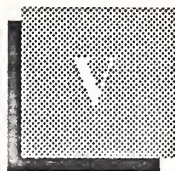
User Perspectives

User Perspectives

A

Challenge versus Opportunity

1. Challenge

Chapter III characterized the productivity challenge faced by the applications development function as an ever-recurring phenomena. After each generation of technology the challenge reoccurs as the demand for information systems continues to grow.

- The application development backlog is a fixture of the information systems environment.

- The installed portfolio of applications continues to grow and with it the maintenance burden.

At the same time the challenge for quality looms as an increasingly important element. Today's applications often cross technologies and departments, share data, and/or use new technologies that must be learned while the application is being developed and implemented.

Today's systems development challenge has the following characteristics: productivity and quality, maintenance versus new development, alternative development resources, and creativity versus discipline. Each of these characteristics is having an impact on the acceptance of CASE.

a. Productivity and Quality

Exhibit V-1 shows the results of asking 100 application development mangers to identify their top three issues. By far the most common response (38%) was productivity, linked directly to quality.

EXHIBIT V-1

APPLICATION DEVELOPMENT—
KEY ISSUES

Issue	Responses (Percent)
Productivity and Quality	38
Use of Technology	16
Responsiveness	14
Development Process	11
Organization and Direction	10
Costs	8
Maintenance	3

- The responses were not clearly differentiated as one or the other; rather, the vast majority of the mentions of productivity included quality as part of the equation or issue.

- Either today's application development manager is still trying to first build a quality system and second do it faster, or these managers realize that quality in the original design process is the only way to attack future maintenance demands. INPUT believes the latter is the case.

b. **Maintenance versus New Development**

Exhibit III-6 characterizes the long-standing allocation of internal development resources. Two-thirds go to existing systems and only one-third goes to new applications. When managers of development look for ways to address productivity and quality, they look for ways to wrestle the maintenance problem into a declining drain on their limited resource pool.

The majority of the CASE vendors and tools do not directly address this aspect of the challenge. Maintenance may gain the most aggressive response from the development manager who truly wants to use technology to attack this problem.

c. Alternative Development Resources

The application development resource of today is multifaceted. It includes the traditional IS development staff, a growing use of external IS development professionals, and the user. And to a greater degree than previously, package software is being used to help meet requirements more responsively. Just managing all of these alternative development resources is a challenge in itself. Adding the use of CASE to each is currently beyond question.

- Exhibit V-2 highlights the magnitude with which both external development resources and package software are being used to meet new application requirements. INPUT found 35% of major projects were using packaged software to meet a significant portion of the requirement. INPUT also found that external development resources were involved in 44% of major projects.

- INPUT research reported in the *1988 Information Systems Planning Report* that 61% of the application development managers surveyed indicated that the end user was actively developing production, versus personal productivity, systems. As the 1990s approach, the end user will become a strong factor in the actual development—design and programming—process.

Given these fundamental changes in the development sourcing alternatives, any major effort to address the development process with CASE technology must consider more than the traditional internal development organization.

d. Creativity versus Discipline

In spite of the efforts to structure the design and programming process, it remains relatively undisciplined in most development organizations. The "not invented here" syndrome drones on and the cry for creative new applications of information technology reinforce the traditional lackluster responses to using highly disciplined design techniques and even 4GL technology for major systems.

The proponents and marketeers of CASE would argue that their technology, in particular front-end tools, does not inhibit creativity, but the

EXHIBIT V-2

SOURCES OF DEVELOPMENT RESOURCES— NEW PROJECTS
(Percent)

Source of Staff	Using Packaged Software	Totally Custom Development	TOTAL
Internal Only	22	78	56
Internal & External	52	48	44
Total	35	65	100

experienced designer who has always done it his way would argue otherwise. In the end, for CASE to be successful, a structured approach to the entire life cycle must be instituted and followed by the entire development organization. And only one technique can be used.

As will be discussed in the rest of this chapter, the rate with which management (let alone the development professional) is accepting the required discipline of CASE is modest at best. Unlike design engineers, systems development professionals have not seen the light of using their own technology to perform their own tasks, let alone do it in a disciplined fashion that matches that used by their peers throughout the IS organization.

The final barrier to using the power of CASE will prove to be getting two—let alone more—systems developers to do it the same way, whether it is designing or programming a system.

2. Opportunity

Using the description of the challenge above it is possible to define the CASE opportunity in the eyes of the application development function as shown in Exhibit V-3.

EXHIBIT V-3

CASE OPPORTUNITY—USER PERSPECTIVE

- CASE Must Address Systems Quality, Perhaps Even More than Productivity.

- CASE Must Provide Assistance to the Current Maintenance Challenge as Well as the Future Challenge.

- CASE Must Help IS Benefit from the Expanding Sources of Development Resources.

- CASE Must Support the Growing Complexity of Application Requirements and Not Stifle Creativity.

- The view of many, if not all, development managers is that improving productivity provides a near-term benefit; whereas improving quality provides lasting benefits toward satisfying system requirements and balancing future maintenance tasks. The lasting benefits of CASE must be quality of design, program development, and documentation.

- Today's problem is dominated by the existing applications portfolio, which is aging and based on old technology due to the move to relational data base technology. Thus the maintenance problem is going to worsen. Many development managers place improving the maintenance problem ahead of new development.

- The development process is changing in terms of who performs the development and the magnitude of packaged software that is used. Adopting CASE must consider these fundamental changes, and over time CASE tools must be useable by the end user as well as the systems development professional.

- Tomorrow's systems development professional must become more of an engineer. Certainly the concepts that have proven successful to the CAD/CAM arena can benefit the systems development process. However, it has been a number of years in the implementation process and even today may have only penetrated 50% of the potential market. It takes time to change the way in which individuals work, in particular those with the strong minds of the systems development professionals.

B
Addressing Productivity—Status Report

Information systems management efforts to address the productivity issues are long standing and evolutionary. As noted in Chapter III, they have been driven primarily by the evolution of programming languages and secondly by paper-based methodologies designed to improve the effectiveness of the specification and design segments. Many of these methodologies have existed for 20 years. It is only in the last two or three years that computer-based productivity tools have appeared in large numbers covering all or most aspects of the development life cycle.

The frequent lack of a full commitment with which prior development tools have been adopted provides a telling indication of the rate of progress that can be expected with CASE technology.

1. Development Methodologies

The practice of using a development methodology has been common since the late 1970s. These paper-based systems (e.g., Yourdon/De-Marco, Spectrum, and SDM/70) are often demanding and address the control process more than productivity. The degree to which they have been implemented in a disciplined fashion varies a great deal, and over the past few years of tighter budgets and decentralization it is safe to say the discipline with which they are used has declined.

As Exhibit V-4 indicates, INPUT found 72% of the development groups are using a development methodology.

- Of those using a methodology, 56% were following a process that had been developed internally. Again it is safe to say that the majority of the in-house methodologies are less structured and less complete that those purchased from the outside. They tend to be life cycle managers, not analysis tools, providing a macro-level view of the application and the development process. These in-house methodologies do not guide or discipline the true design process.

EXHIBIT V-4

SYSTEM DEVELOPMENT
METHODOLOGIES—1988
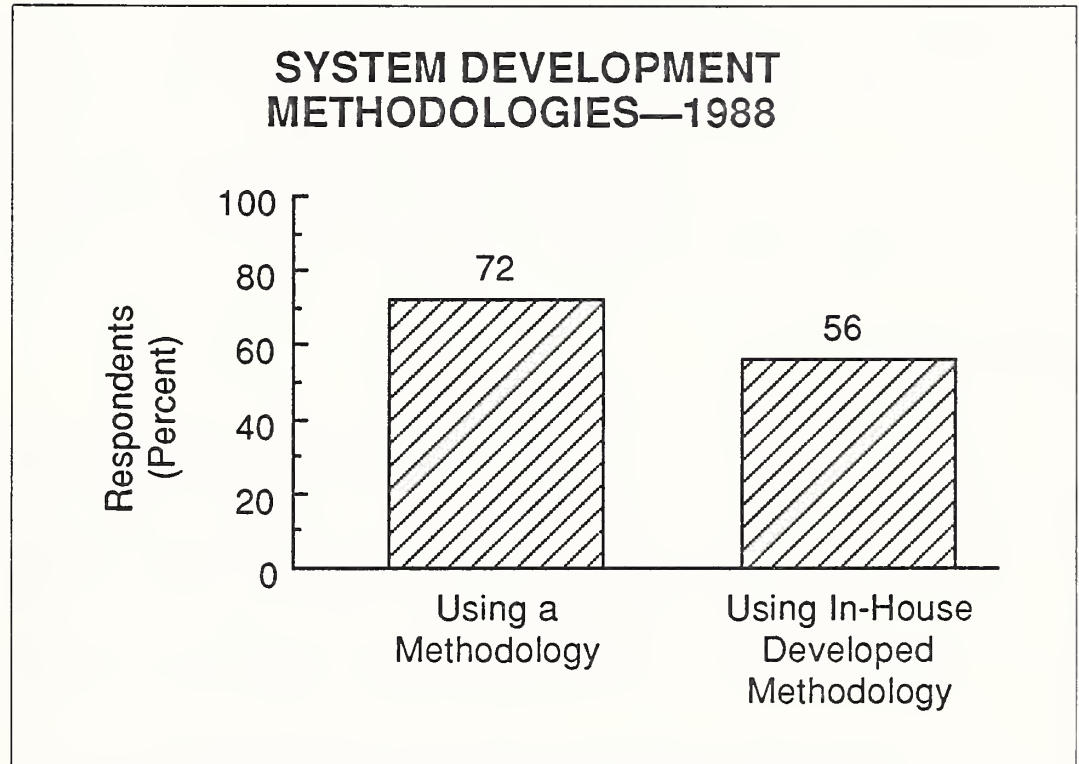
• None of the formal, purchased methodologies mentioned was dominant. Those mentioned included SDM/70, Spectrum, Stratus, Method/1, Yourdon, and IBM's Information Systems Planning.

The implications for CASE and its adoption are found in the belief that without a development methodology in place and true experience with structured analysis and design processes, those who try CASE will have great difficulty with the current front-end CASE design tools. To paraphrase the president of a leading CASE technology vendor, "if there is not an existing methodology in disciplined use, we try to provide one to assure the success of our product."

2. Fourth-Generation Languages

Introduced in the 1980s, the 4GL technology was first an answer to productivity and second, provided end user access to mainframe computing. 4GLs have been only a partial success in both areas, and experience has shown that the end user has been more successful with PC technology. Furthermore, the limitations of 4GL technology has restricted its use in many critical application systems areas.

Not surprisingly, 70% of the organizations interviewed use a 4GL; yet since 4GL technology only addresses the programming phase of the development life cycle, a more-comprehensive answer is needed.

3. CASE Activity

CASE technology has been on the market in various forms for a few years and grew into a sizeable market in 1986 and 1987. The interest level is very high, but the level of adoption and actual use is modest. Exhibit V-5 summarizes INPUT's findings relative to the acceptance of CASE technology.

EXHIBIT V-5

ACTIVITY WITH CASE—1988

Have an Organized CASE Project	30
Considering, but Not Using CASE Tools	20
Using CASE Tool	24

0   10   20   30   40

Percent of Respondents
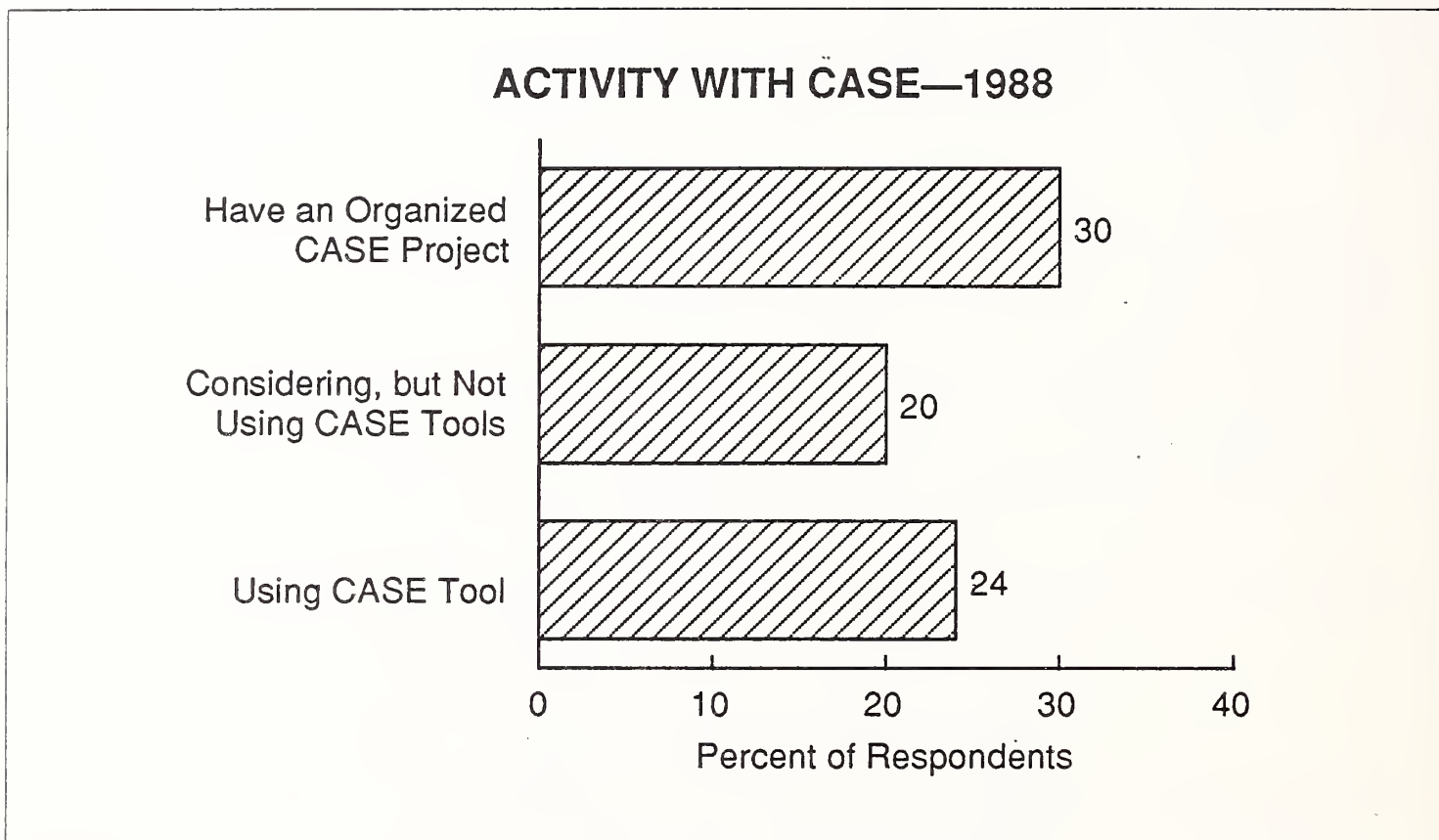
- Only 24% of the organizations surveyed were actively using CASE tools, in particular design tools, and almost without exception that use was on a pilot basis with one or two active design projects.

- An additional 20% indicated they were considering (investigating) CASE, but had not adopted any tools, even in a pilot stage.

- Separately, 30% of the organizations had an "organized" project that was addressing application development productivity. In most instances these projects were lead by a development manager/project leader and were either in a pilot project with CASE or were conducting a structured assessment and selection process.

In subsequent interviews with CASE project leaders only one instance out of about fifteen was found where preparations were in process to roll out a CASE design tool for general use by the entire development staff.

These findings are reinforced by one of the leading design tool vendors that indicates 70% of its current clients are in the experimentation stage. Another 20% can be classified as truly using the products and only 10% have put it in general use.

C
CASE Experiences

To complete INPUT's user perspective of CASE and the progress in adopting CASE tools, 15 project leaders were interviewed. These individuals were usually a development manager with a special assignment to support the assessment, selection, and implementation of CASE technology.

In addition, a series of case studies were developed, two of which are presented in this section.

The objectives of these efforts were as follows:

- Gain firsthand insight into the pitfalls of the CASE deployment process

- Obtain a perspective on the length of time required to deploy CASE technology

- Determine what the critical success factors were

- Assess the level of satisfaction versus progress made

- Understand how users of CASE view the technology currently available

1. User Experiences

The following reports individual summaries of many of the project leader interviews. They quickly and clearly indicate much of the challenge faced in deciding to use, let alone deploy, CASE.

- "We selected our first design tool because an analyst had used it elsewhere and wanted to continue using it. A single copy cost only $2,000 so why not give it a try? We have learned a great deal and have two projects underway using a broader, more integrated CASE product that at least starts the code generation process. It takes an experiment or two to set the criteria for selection of CASE tools."

- "We based our decision on the level of product integration and local vendor support. Knowing we had a learning curve in front of us, we wanted to attack CASE with a product with broad capabilities and a company that would be there to help us. Although the training was typical of software vendors, it got us started and the support was solid."

- "It did not take long to realize that our development methodology was inadequate. While in use for a number of years, it did not do the job in the truly structured fashion. The vendor said it was an ingredient to success with CASE and he was right."

- "The pilot has taught us a great deal about how the development culture and process must change to really use CASE technology. We have to back up and do training in the structured analysis and design area before we place CASE in general use. Given the size of our development staff (over 200) there will need to be much energy, time, and commitment along the way."

- "Much, if not most, of what we do is enhancement and maintenance; new systems are often based on package software. Because of this, we are concerned about the 're-engineering' tools. If those tools support the re-engineering process truly work we will be interested. We have been using testing products (e.g., Expiditer) for a while; however, code analyzers are still too new and expensive to justify. The CASE vendor who unravels the maintenance problem will get our attention."

- "We are interested and experimenting, but are not convinced the technology is mature enough to make a full commitment. The PC-based design products are reasonably priced, but when you add up the cost of PCs and software licenses for the entire development staff, justification is tough. The price of code generators is just too high to justify right now, and they need to also address the maintenance aspect as well."

- "Right now we are using multiple products. In many cases, the designer is using Analyst/Designer Toolkit from Yourdon as a diagramming tool and doing the rest of the design the old fashion way on paper. Others are using Information Engineering Workbench (IEW) from KnowledgeWare for the full design process. And we are experimenting with Foundation from Andersen Consulting. We will figure out the real strategy in 1989 after these experiences play out."

- "We have five projects underway that are using IEW in all aspects, from specification and design to data modeling and screen development. Included are a warehousing system that is being completely redesigned and a services scheduling application that is brand new."

Specific comments concerning the products in use included the following:

- "You need to understand the underlying philosophy of the design tools and how they match the development culture. Excelerator from Index Technology takes a "process" orientation to the analysis and design activity whereas IEW from KnowledgeWare is more data- and relationship-oriented. The end result may be similar but the steps and benefits are different."

- "Some tools are more inflexible than others. There are pluses and minuses in both approaches. What is key is realizing the degree of inflexibility in the product chosen."

- "There just is not a total answer on the market today. This makes selection much tougher. Buying more than one tool creates interface problems and operational exposures. And it complicates the training process. It just seems too expensive at this point."

- "The reverse engineering products hold a great deal of promise, but are not really viable today and are expensive. We will just wait."

- "The cultural impact of adopting the front-end design tools is immense. It will take a long time (years) to gain the full commitment and understanding required."

- "The learning curve varies with complexity. To make full use of the capabilities takes a great deal of experience. Otherwise what is learned is soon forgotten."

All of this adds up to cautious curiosity. The systems development profession seems to know it is on the edge of a major evolutionary step but is not sure if it is ready to march forward with vigor.

2. Case Study No. 1

a. Business Environment

USER1 is one of the world's largest discount stock brokerage firms. It currently maintains a system of over 100 branch offices, each of which provides computerized trading and stock quotations to customers and brokers. An uninterrupted flow of information, order and transaction processing, high reliability, and complete reconciliation processing are cornerstones of USER1's business.

Most of USER1's processing occurs on two IBM mainframes, one in New York and another at its headquarters in San Francisco. In addition to

the mainframes, USER1 employs numerous IBM Series/1 and personal computers in its branch offices. It also collects and processes information from Quotron systems, which consolidates information about Dow Jones and other financial transactions.

USER1 develops system software to support its custom network; application software for transaction and order processing; and customer-oriented products to encourage customers to use USER1 services.

b. Organization Structure

This product group was originally a separate organization set up by an ambitious development manager who planned to create a spinoff company to sell customer-oriented products. The products were supposed to be created as enhancements to existing USER1 services. The development manager hired good people and staffed a product organization, but when the products were delivered, it was discovered that the revenues generated from product sales and associated services did not meet the costs of the support organization. This organization was disbanded, and technical resources became a part of the in-house systems development group. The development manager is no longer with USER1.

USER1's current development organization is divided into two groups: application development for the mainframes and system development for the Series/1's, personal computers, and other computers. In addition, USER1 employs several people in support of the mainframe system environment. USER1 employs roughly 80 application programmers and 20 system programmers and designers. It also makes use of independent contractors on individual projects to supplement its in-house expertise.

c. Current Development Techniques and Development Philosophy

The vice president of software development is in the process of revamping resource allocation and productivity in software development throughout the organization. He states that for the application developers, between 60% and 75% of an individual's time is devoted to maintaining existing systems. In addition, its mainframes are overloaded.

The vice president's initial charter is to move as much application development as possible from the mainframe systems to the personal computers. This idea is popular with both upper-level managers and programmers. Programmers' prime complaints at USER1 revolve around the lack of availability of the mainframe systems.

He is currently examining PC-based development systems that target IBM mainframes for execution. He is conducting extensive studies of CASE tools that will help him achieve the goal of off-loading mainframe

development activity to personal computers. As part of his project, The VP had to completely understand all aspects of the development environment at USER1 to ensure that developers maintained as much capability as possible in migration. The results were surprising.

Coming from the systems development side of the organization, he was dismayed at the lack of a formal development methodology in the application development area. He found inconsistencies in the tools and that few standardized procedures used; he even found that the COBOL development organization used three different, incompatible levels of compilers. The VP hopes to standardize on COBOL 85. With luck, use of a uniform language will assist in formalizing the application development process.

He also met with significant resistance when he attempted to quantify and subsequently label certain development activities as maintenance. Politically, the programmers do not want their job descriptions to contain significant maintenance activities.

His conclusions are that he can demonstrate significant productivity gains through enforcing formal development methodologies across the organization. While he believes CASE tools will be useful, he characterizes them as carrots he can hold out to ensure compliance. Since everyone wants to do development on PCs, he believes that they will accept the necessary procedures. Because design, coding, and some unit testing will be done remotely from the target mainframes, it will be necessary to formalize these phases, their products' interactions with the mainframes, and developers' interactions with each other.

In other words, CASE itself will not be responsible for the productivity gains. Rather, CASE will be the means to assure formalized development procedures where none have existed before.

While he feels that the prices of CASE tools are "outrageous," his projections demonstrate that because of the growth in the demand for applications, use of mainframe resources for development (currently costing his organization an estimated $180,000 per month in recurring costs), will increase to nearly double that figure in five years.

If he can move significant portions of development to PCs, total costs, including amortization of CASE tools, will be $200,000 per month. But these figures will fall off dramatically over the next 24 months as productivity gains are seen and resources are paid for. Overall, USER1 expects to save several million dollars over the next five years with a PC-based development project in place.

Still, he does not feel that this savings can be attributed to CASE per se.

He believes that improving productivity and reducing maintenance costs will be the result of formalizing and enforcing proper development methodologies, rather than the CASE tools themselves. Officially, however, CASE may get the credit; the organization will never officially admit the problems that exist in the development organization.

d. Conclusions

USER1 is typical of many commercial organizations with large development backlogs. Implementing CASE will improve productivity within the organization and will probably aid in reducing the development backlog.

A major problem in the development organization, and a major factor in the application development backlog, is the lack of a formalized development methodology.

Politically, formalization is unpopular, while PC-based development is very popular. Therefore, USER1 will use PC-based CASE tools to help implement a formal methodology to improve productivity and reduce developmental backlog.

Although USER1 can cost justify the purchase of CASE tools, it feels the prices are "outrageous" because it believes that nearly the same productivity gains could be made by enforcing methodology without CASE. Still, politically, it would be difficult to provide this enforcement without the tools.

3. Case Study No. 2

a. Business Environment

USER2 is one of the United States' major defense contractors. It employs nearly 15,000 people in several locations around the country. Of these, more than 30% are technical personnel. USER2 is representative of the aerospace industry, which is itself very different from most commercial enterprises.

Most aerospace business is generated by government agencies, and in particular, the department of Defense (DoD). In the commercial sector, a large development project requires about 100,000 delivered source instructions (DSI). As mentioned, most of these application development projects are not complex and are typically an automation of manual processes.

In DoD environments, an average contract will result in over one million DSI. Projects generally involve developing systems and applications that

have never been created before, and for which no real-world examples exist. This order of magnitude, difference in size, and exponential increase in complexity makes software development in this environment particularly difficult. Projects of this size usually employ 700 people, roughly 200 of which are programmers.

b. Current Development Techniques and Development Philosophy

The DoD requires detailed documentation of each phase of the waterfall-like development life cycle. According to the Corporate Director of Engineering Technology (DOT) at USER2, 35% to 40% of a project's man-hours is dedicated toward documentation. Because of this, the overall proportions of the development life cycle are skewed over those of a commercial environment. With documentation factored in, the proportions in the USER2 environment are as follows:

- Requirements and Architecture   15%
- Detailed Design   25%
- Coding   10%
- Integration and Testing   30%
- Customer Acceptance Testing   20%

Maintenance is not considered part of the development cycle because either USER2's customers perform the maintenance, or establish separate contracts for maintenance. USER2 generally does not assign the original developers maintenance contracts, so maintenance is considered a separate project. Of USER2's delivered projects, the DOT estimates that 50% are maintained by the customer or another firm, and 50% are maintained by USER2.

Project staffing is done across the location boundary. Individuals are assigned to projects based on their areas of expertise. They are not moved to a central site for the duration of the project. Instead, they work independently at their own sites, but interact through USER2's development network.

USER2's network currently consists of Digital Equipment Corporation's VAX machines linked through a variety of terrestrial and satellite circuits. USER2 has developed a complete, partially integrated set of CASE tools that runs in the distributed development environment. Although this system assists in managing distributed projects, messaging requirements for management reports, and accessing reusable code libraries, design and coding interactions between developers have overloaded the systems.

When asked if a software development crisis exists within USER2, the DOT explained that because there are no ongoing unfunded maintenance activities, no crisis exists in USER2 or any other aerospace company,

unlike in the commercial sector. Still, he believes that improving productivity will lead to greater profitability and a competitive edge in making large bids.

c. Development Philosophy

USER2 has begun a five-year project to create its own fully integrated CASE development environment. The system will be based on Sun workstations tied together in LANs within individual locations. The locations themselves will be interconnected through high-speed bridges.

Of primary importance in USER2's new CASE environment will be the refinement of its reusable code libraries and associated CASE systems. Much of the new system will be AI-based. The project management system will be fully integrated and will provide project tracking based on pre-established metrics for each phase of development. During the analysis and design phases, it will automatically assess the viability of code from reusable libraries. From this analysis, it will establish project schedules and actively participate in managing the project by tracking activity in the configuration mangement system. If there is lack of activity in areas that will soon be due, it will alert management to the problem and suggest alternative approaches to resolving the scheduling problem.

The system will also generate and monitor test scenarios. In addition, it will provide the tracking necessary to demonstrate to customers that specific functional requirements are implemented in identifiable sections of code and that test suites address the requirements. Since 50% of its development effort is devoted to testing, automated test tools will have the greatest impact on productivity.

In fact, the DOT projects that USER2 will see a 100% improvement in software productivity within five years of the system's installation and a 200% improvement within 10 years, as the base of reusable code grows.

USER2 is actively involved with the Software Productivity Consortium in establishing standards for software development, CASE tools, and project management procedures.

The consortium is committed to Ada as a standard programming language, using the Ada Design Language (ADL) as part of its design specifications. The DOT believes that this is the prime reason why coding demands only 10% of any development project. This coding, too, may be automated as its CASE tools are developed.

USER2 is also committed to UNIX as a standard operating system. When confronted with the inefficiencies in both Ada and UNIX as CASE standards, the DOT responded: "All systems have inefficiencies. It is

more important to have uniformity than to have efficiency." He went on to explain that without standards, a truly reusable code will never exist. As far as inefficiency is concerned, "Programmers today have workstations on their desks (Suns) that are more powerful than the largest systems 15 years ago. Computing capacity will not be a problem for long."

When asked about object-oriented systems, the DOT indicated that USER2 had recently completed projects that required object-oriented sytems. He believes that in large projects, too many objects are required. Because the DoD has specified that design documentation must include hierarchical control flow diagrams, USER2 had difficulty meeting DoD documentation requirements with the object-oriented systems.

Meeting DoD documentation requirements is always a problem. As such, USER2 has developed automated documentation tools that generate documents at each phase of the development cycle, as specified by the DoD. Still, the DOT considers much of the documentation unnecessary. In one project, several months after it was delivered and operating efficiently, the customer requested updates to the original preliminary requirements documents.

Since many iterations of prototypes had occurred in the intervening stages of the project, it required $2 million and two years to update the specifications to reflect the working product. The customer has never looked at the new preliminary functional specification.

For this reason, the DOT is lobbying with the DoD to revise documentation requirements. Since this represents up to 40% of a project's effort, the DOT believes that with reduction of this requirement, USER2 could see substantial improvement in productivity over the average 200 DSI/man-month that USER2 realizes today.

d. Conclusions

USER2 is representative of the aerospace industry and of the large organizations that perform huge software development projects on orders of magnitude more complex than those found in commerical environments.

In order to successfully complete these projects, rigorous development methodologies are essential. However, in these particular environments, the excessive documentation requirements have reduced the software developers' productivity to a mere 200 DSI/MM.

USER2 now targets two major areas to improve overall project productivity:

- Reusable code libraries

- Custom CASE tools to augment productivity at all stages of development

With projects are as large as these, small improvements in productivity generated through use of CASE tools justifies their expense.

VI

Competitive Environment

VI
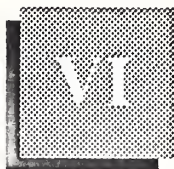
Competitive Environment

A
Competitive Overview

Chapter IV, Market Analysis and Forecast, provided an overview of the CASE market, its state of evolution, and its structure. In this chapter INPUT looks at the individual vendors, their competitive posturing, and what the next few years may bring for an individual vendor versus the entire market.

Exhibit IV-6 (repeated here as VI-1) defined three categories of CASE vendors: (1) CASE tool developers, 2) methodology-based vendors, and (3) DBMS and 4GL vendors. Each of these categories comes to the market from a different point of view and with different strengths and weaknesses affecting its competitive posture.

EXHIBIT VI-1

CASE VENDOR CATEGORIES

- CASE Tool Developers: Developers and Marketers of CASE Software Tools, Either Front End, Back End, or Both.

- Methodology-Based Vendors: Developers and Marketers of CASE Software Tools Where the Tools Are Based on a Specific Development Methodology.

- DBMS and 4GL Vendors: Developers of Application Development Tools That Are Adding CASE to Their Proprietary Product Line.

1. CASE Tool Developers

To date, these companies have focused on either the front- or back-end CASE technology and have had a focus of keeping their technology one step ahead of the competition. They have marketed to the information systems organization on the basis of improving productivity and where beneficial, downplayed the impact on the culture.

a. Front End

The front-end tool developers, in particular, have used a "try-it-you-will-like-it" philosophy.

* They benefit from a low entry cost due to the use of personal computer technology. The cost only becomes significant when the technology is rolled out for general use.

* They indicate that while a development methodology is a requirement, which one is not important. "We can support any methodology as long as one is used," is the standard pitch.

* They open the door by finding an aggressive and progressive development manager and hope for success on the first pilot project.

The front-end companies support their products with the standard training and education services, but have not felt a need for more supportive consulting services.

* Only one vendor spoke aggressively about its support services plans.
* The highest percent of revenue for support services was 10%.

b. Back End

The back-end code generation vendors, specifically Sage have a much more involved sale. It follows the scenario of the 4GL introduction where a high-level technological buy-off is required.

* The investment is high. Making a mistake is very costly.

* The implications for current applications are significant.

* The impact on the development culture is, at first, higher than an experimentation approach with the design tools.

It is simply a tougher sale. The best targets have proven to be information systems with relatively strong new development plans and a larger, still-centralized systems development function. The sales cycle has proven to be quite long, over six months.

c. Summary

The primary competitive issue for these vendors is continuous techno-logical advancement and the full I-CASE product line.

- Until the buyer makes the commitment for general use for design tools there is the chance that another vendor can enter the process and sug-gest a second trial. It was not uncommon to find more than one front-end vendor's products under test in the user survey INPUT conducted.

- Meeting the full I-CASE product line target may prove to be the meas-ure of survival. Those that make it will be able to compete in a mature market. Those that do not will either form very strong alliances or see a declining market position.

2. Methodology-Based Companies

As stated previously the basis for methodology companies is the applica-tion of technology to a specific set of principles. It may be said that these companies are taking the true engineering approach to CASE—develop-ing a set of scientific principles and then computerizing them.

The competitive posture of this category is best understood by example.

Texas Instruments (TI) has chosen to develop a full I-CASE product family (Information Engineering Facility™ or IEF).

- IEF is based on a single methodology from James Martin Associates. The user must adopt this approach to the life cycle.

- IEF provides a full life cycle support system.

- IEF requires a total commitment by the systems development organiza-tion and the entry fee is very high.

A second example is Bachman, which is just releasing its first products. The current financial commitment is different than that with TI, as Bach-man's first products are personal computer based and are focused on the data administration function. But, there is the same buy off on methodol-ogy.

- Bachman's focus is the re-engineering process to bring new life to existing applications. Its methodology focuses on the data base and logic definition process and requires that the data administration func-tion begin to do it the Bachman way.

- As its product family grows it will include design tools. These tools will again be tied to a specific design methodology under development with the help of Chris Gane, one of the developers of the Sarson/Gane methodology of the 1970s.

- By attacking the data modeling and administration area, Bachman hopes to minimize the early cultural impact of its technology.

The key to the success of these vendors will be their ability to clearly expound their methodology, to keep that methodology moving forward with the technology and to provide the consulting support the buyer will require to make the total absorption of one company's approach to systems development.

These vendors can be expected to develop more slowly, to have higher customer loyalty, and if early success is achieved, have longer staying power.

3. DBMS/4GL Companies

This last category can be called the CASE vendors of necessity. If they want to retain account control and continue to grow within their client base they must add technology to their current products. The direction is to move back up the life cycle to design and project management tools and to turn their 4GLs into true application code generators.

For the most part this category of CASE vendors is just beginning to appear in the market. Examples of competitive strategies include:

- Pansophic—Although Telon has been around since 1984, it has now begun to play a role in a broader strategy; first through multiple alliances with various front-end companies, and now, through a joint development and marketing agreement with Cadre Technologies, Pansophic is preparing to position itself as a full I-CASE provider.

- Oracle—As with all elements of its technology, Oracle is developing CASE tools. Building on its easy-to-use 4GL and Oracle/Forms products, the company will begin to provide graphics-based design tools that work with the Oracle SQL data base. And given its end-user orientation, Oracle may be an early developer of CASE design tools for this very large market segment.

- Cullinet—In its effort to breathe new life into IDMS, Cullinet has licensed technology from Learmouth & Burchett Management Systems based in England and developed IDMS/Architect to support the design process for IDMS-based applications.

As the CASE market reaches early maturity over the next few years larger software companies and hardware vendors will play a stronger role in the evolution of the final CASE environment and market.

B

CASE Vendors

Appendix A, Independent CASE Vendor Profiles, and Appendix B, CASE Product Profiles, describe the direction and products of most major and emerging CASE vendors. The following comments on a few of them provide examples of where this market is expected to head over the next five years.

1. Leading Vendors

The leading vendors discussed in this section are described in Exhibit VI-2.

EXHIBIT VI-2

LEADING CASE VENDORS

Index Technology	The Largest Vendor, One of the First, with a Front-End Focus
KnowledgeWare	The First U.S.-Based Front-End Tool Developer to Introduce a Code Generator
Cadre Technologies	A Real-Time Systems CASE Vendor Trying to Enter the IS Market

a. Index Technology

Index Technology is the current recognized leader in the CASE front-end marketplace. With sales approaching $30 million in 1988 and a well-established reputation for providing quality, easy-to-use design tools, it has captured the largest market share.

Key elements of Index's strategy include:

• An early focus on the information systems (IS) sector (the largest) of the market

- Alliances with all of the major code-generation companies

- A focus on the design portions of the development life cycle (not trying to do it all)

- Expansion into the real-time systems sector

The primary exposures are:

- Index is not in the I-CASE business and has no apparent plans to move into the back-end area of CASE except through affiliation. This approach may prove to be a weakness in the long term.

- The ever changing power of the PC. Index was able to leapfrog others with its design tools, which means someone also can do the same if it does not maintain a strong development level. Will Index be the first to truly take advantage of the power of OS/2 Extended Version?

b. KnowledgeWare

Currently number two in the IS market, KnowledgeWare has made the move to I-CASE with the introduction of IEW/GAMMA on a fully integrated basis. IEW/GAMMA claims to be the most tightly integrated front- and back-end CASE product on the market. An I-CASE product line will result in an increased percentage of KnowledgeWare's revenue coming in very large contracts for total systems. If successful, it can provide the full solution and be a single point of client support.

KnowledgeWare's major exposure may prove to be the investment required to support a full I-CASE environment. It has received development funding from Arthur Young in the past and believes that future development will require some type of R&D partnership to meet the required investment.

c. Cadre Technologies

To date, Cadre has focused on the real-time systems area, a narrower and more-specialized market. It is the biggest and most successful company in this market, but remains smaller than the major competitors in the IS market.

During 1988 it began to move into the larger IS market and has introduced a PS-based version of Teamwork. However, the basis for this product was acquired from Structsoft Inc., and may vary from the successful Teamwork product family that runs on Sun, Apollo, DEC, and other workstations. To market this product Cadre has formed a strong alliance with Pansophic, which is marketing TEAMWORK/TELON.

Cadre's success in this larger market is currently tied to Pansophic more than its own marketing efforts.

2. Emerging Vendors

The emerging vendors discussed in this section are described in Exhibit VI-3.

EXHIBIT VI-3

EMERGING CASE VENDORS

Bachman Information Systems	The First to Truly Address Re-Engineering.
Softlab	An Established German Vendor Entering the U.S. Market.
Texas Instruments	A Full I-CASE Vendor with a Very Specific Solution.
Andersen Consulting	A Professional Services Company Applying Technology to its Proven Methodology.

a. Bachman Information Systems

A late entry into the CASE front-end market, Bachman is approaching it from the methodology point of view. As a result it has a very specific story to tell that is of interest to those trying to maintain large data base-oriented application portfolios.

Bachman is very well funded and has the benefit of learning from others' mistakes. Its focus on the data modeling area has very high appeal, because it addresses maintenance as well as new development and may be implemented—at least to start—with less cultural impact. Time remains for the majority of the IS organizations to try an approach like that offered by Bachman and to wait for the company to broaden its product family.

b. Softlab

Based in Germany, Softlab, although a relatively new entry in the U.S. market, is in fact one of the largest CASE vendors in the world. Its MAESTRO® product is a full I- CASE product with almost 500 customers worldwide, but under 20 customers in the U.S. as of late 1988.

The strengths of the Softlab approach is hardware and language independence, an integrated project management control process and a full set of CASE tools. MAESTRO uses a minicomputer plus a workstation environment and thus has the benefit of off-loading the host; however, a negative is the adding of another level of computing to the systems development environment. Another negative is an entry price of $250,000. MAESTRO is for the serious CASE user.

c. Texas Instruments (TI)

TI is mentioned as an emerging vendor because 1988 is the first full year of sales for its Information Engineering Facility (IEF™). TI has probably made the greatest investment to date of any CASE vendor and has brought to market perhaps the most focused and structured I-CASE product family. From methodology to the code generator and the data base (DB2) that must be used, TI has defined a single path to the development promise.

TI expects 1988 to prove to be a very successful year and will enter 1989 as a serious player in the CASE market.

d. Andersen Consulting

Andersen Consulting's FOUNDATION™ is the result of applying information technology to its own system development life cycle methodology. As it did this for internal purposes, it became apparent that it could be sold outside. The result is a major CASE product family consisting of three products: METHOD/1, DESIGN/1, AND INSTALL/1.

The front-end tools, METHOD/1 AND DESIGN/1, can be compared to Excelerator and IEW. INSTALL/1, on the other hand, is tied specifically to IBM's DB/2 relational data base environment. Andersen Consulting, like the other major consulting firms, has recognized that the way it does work for its clients is an asset that can be remarketed.

Now Andersen is in the software business and is adapting its strategy to support such a business, including a specialized sales and marketing function for software products. Andersen Consulting has one advantage over other vendors: It is in the professional services business and believes in it. As a result, its approach to the CASE market is likely to

include an emphasis on support services, unlike the technology-based vendors. This approach could prove to be an advantage over time.

See Appendix A and B for more information on these and other CASE vendors.

C
Evolving Market Strategies

1. Alliances

As noted in Chapter IV, alliances are playing a very important role in the early evolution of the CASE market. Exhibit IV-8 provided a list of the types of alliances that INPUT identified in its research. Exhibit VI-4 identifies many of the relationships that exist today.

This list is certainly not complete, yet it quickly provides a picture of the intertwining relationships that are developing. Even IBM has stated that it expects to build an I-CASE product line through internal development and alliance. IBM can be expected to develop and support the back-end tools (mainframe based) and to turn to the outside for the front-end, PC-based tools that will eventually carry the IBM name.

Many of these are relationships of convenience. For example:

- Index Technology has alliances with at least three code generation vendors. In each case modest efforts have been made to build an interface between Excelerator and the specific code generator. However, none of these relationships is believed to be more favorable than the others.

- Sage Software and Pansophic (Telon) have done the same in reverse with alliances with multiple front-end tool companies.

Others are more serious, often involving development funding and equity positions.

- Deloitte Haskins & Sells' relationship with Holland Systems is providing methodology, funding, and ongoing support.

- Arthur Young's relationship with KnowledgeWare has included development funding, client support, and international marketing.

- Cadre Technologies' relationship with Pansophic includes funding, joint development, and significant marketing rights.

INPUT expects that these relationships will either turn into permanent partnerships (marriages) or lose their significance over time. To carry weight in the market the partnerships must lead to I-CASE products and a

EXHIBIT VI-4

CASE RELATIONSHIPS

Company	Alliance	Nature of Relationship
KnowledgeWare	Arthur Young	Joint Development Equity International Marketing
Index Technology	Pansophic Sage Software Cognes Holland Systems	Code Generation Code Generation 4GL OEM
Sage Software	Perot Systems	Marketing Rights
Holland Systems	DH & S	Methodology & Joint Development
Cullinet	LBMS	Redevelopment Rights
Pansophic	Index Nastec McDonnell Douglas Cadre	Front End Front End Front End Front End & Equity
Cadre Technologies	Relational Technology General Electric Hewlett-Packard	Joint Development Joint Development OEM
Transform Logic	IBM	Joint Development
Nastec	Sage Software Coopers & Lybrand	Code Generation Methodology & Joint Development
Atherton Technology	Digital	Joint Development
Cortex	NCR	Joint Development & Marketing

single point of customer support. Mergers and acquisitions are expected in the near future.

2. Future Directions

The next few years can be expected to bring significant change in the strategies of CASE vendors and in the CASE market itself. Today there are easily 200 vendors claiming participation in the CASE market. By 1993 this number will have been reduced significantly; the market will have reached reasonable maturity, with greater than 50% penetration; and the more mature end user will be using CASE with his or her departmental computer.

The trends listed in Exhibit VI-5 and described below are expected.

EXHIBIT VI-5

CASE—FUTURE DIRECTIONS

- The True Leaders Will All Become I-CASE Vendors.

- Professional Services Companies Will Play a Critical Role in the Growth Rate of the CASE Market.

- Support Services from CASE Vendors Will Play a More Important Role Than Currently.

- The Repository Element of the I-CASE Environment Will Prove to be the Link That Makes CASE a Lasting Success.

- Selling CASE Design Tools to the End User Will Provide a Second Wave to the Market.

- The true leaders will all become I-CASE vendors.

  - Although the user will reserve the right to select the code generator separately from the design tools, it will become common to go with a single vendor for broad-based support.

- Professional services companies will play a critical role over the next few years in the growth rate of the CASE market.

  - They will, of necessity, be two-faced about which CASE tools they use. Each will have its own preferred systems, but will be ready to use the system of choice of the IS organization they are serving at the moment.

  - They will use it for business success, thus truly demonstrating to their clients that CASE can be of value.

  - Their use, in affiliation with CASE vendors, will drive further improvements in the technology.

- The inclusion of support services, that is true consulting and implementation support and not just training, will become important by 1990-91.

  - The current tendency to downplay broad support services by CASE vendors will begin to have a negative impact on market growth in the next two years.

  - Vendors that place emphasis in this area will gain competitive advantage as the overall number of vendors declines.

  - Professional services are proving to be a competitive advantage for many of today's leading software vendors. The same can be expected in the CASE market.

- The repository element of the I-CASE environment will become a reality by 1991-92 and will prove to be the link that makes CASE a lasting success.

  - The lack of a full-function repository is the weakness in most CASE environments today and is the focus of much development.

  - IBM will deliver at least a starting point, and other vendors will provide a reasonable substitute by 1990 to remove this lack as a blocking factor from the CASE decision. Some vendors, including Andersen Consulting, TI, and Softlab already claim they have the basis for the repository in their existing products.

  - The priority of controlling the data infrastructure of today's, let alone tomorrow's, data network make the concept of a full network encyclopedia mandatory.

- Selling CASE design tools and easy-to-use code generators to the end user will develop into a true market by 1992 or 1993.

- This will open up a second generation for CASE vendors.

- Vendors that have specialized in the front-end area and do not conquer the back-end area may find added life and opportunity by being the first to build CASE tools that the end user can use.

- The requirement is for further graphical interfaces and the "hiding" of the data modeling and data base definition process.

- The leaders in this area may prove to be the DBMS/4GL vendors and not the initial developers of CASE technology.

VII

Conclusions and
Recommendations

VII
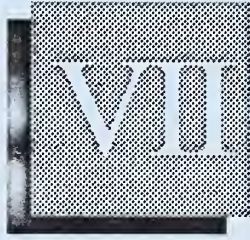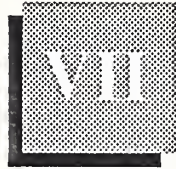
Conclusions and Recommendations

A
Conclusions

1. The Opportunity

The opportunity is to do for the systems development process what has been done through CAD/CAE for the engineering process—discipline and improve the productivity of the systems professional through the computerization of the entire life cycle. All of the CASE vendors reviewed for this report believe they are on the way, but a great deal remains to be done.

- Today's CASE technology could be classified as the first generation providing many tools—both front and back end—with some interfaces between them; but not full integration.

- A second generation will offer the reverse or re-engineering capabilities that permit CASE to be applied to the maintenance challenge. This generation is already beginning to appear and will help speed the general acceptance of CASE.

- A third generation of CASE technology will appear over the next two to four years. This generation will conquer the interface challenge—providing true I-CASE capabilities—and will provide the repository to support the life cycle. This generation will assure CASE becomes fully imbedded in the development culture.

- A fourth generation can then be anticipated that will move the benefits of CASE into the hands of the qualified end user, the systems developer of the mid and late 1990s.

In this context there remains a great deal to do and a natural hesitancy by the information systems buyer in accepting CASE as it now stands. The full evolution will consume the majority of the next decade.

2. The Market

The market has reached a critical mass with 1987 revenue in the U.S. of $125 million, and $200 million worldwide.

The market is complex and consists of many subsectors. The market can be segmented by:

- Use: Information Systems Development, Commercial Software Products, Real-time Systems

- Product: Front End, Back End, I-CASE, Re-Engineering

- Vendor Type: Tool Developer, Methodology-Based Company, DBMS/4GL Company

Penetration remains modest (about 5%), characterizing the market as emerging. It is growing fast, yet remains open to new concepts. Today's technology, in particular for front-end products, remains exposed to a better idea. Even the code generation (back end) area has room for significant technological advances, and some appear to be on the way.

The vendor population is large (perhaps 200) and is still growing. New and established software vendors are still entering the market. The largest vendor has perhaps 15% of the U.S. market.

Support services from CASE vendors have not been fully developed. Although there appears to be adequate training, some of the reluctance of information systems management may be due to the level of support available.

- Of significance may be the consulting support required to deal with the cultural, versus the technological, issues.

- It may be that the real winner will be the CASE vendor that provides a winning solution to the cultural challenge and not the vendor with the best technology.

In the U.S., and worldwide, the CASE market will grow throughout the next five years at a rate much faster than the overall software market; perhaps twice as fast.

3. User Acceptance

Current user acceptance can be best characterized as a mixture of experimentation and caution. As with all new technologies there are those that are stepping forward and pioneering the application of CASE. But in general, the rate of acceptance is modest.

INPUT found that one information systems organization in four was experimenting with CASE, but none were truly rolling it out for general use. The key to market growth over the next two years will be in the general acceptance of this technology.

One of the long-standing blocking factors to using new technology has been the information systems themselves. Their never-ending quest to do a quality job in the face of rapidly changing technology makes them resistant to discipline. Yet the benefit of CASE comes through discipline in the way systems are built. Seeking the balance will remain a challenge for information systems management well into the 1990s.

B
User Recommendations

1. User Requirements for Success

INPUT makes the following recommendations, as listed in Exhibit VII-1, to information systems organizations concerning CASE.

EXHIBIT VII-1

CASE—USER REQUIREMENTS FOR SUCCESS

- Experiment with the Technology, Do Not Just Conduct an Assessment.

- Understand the Depth and Breadth of the Impact of CASE on the Development Culture.

- Adopt an Active, Well-Disciplined Development Methodology.

- Make a Strong Commitment to Structured Analysis and Design Techniques.

- Do Not Ignore the Maintenance Challenge When Considering CASE.

- Set Well-Defined Objectives for CASE and Measure Progress.

- The benefits of front-end CASE are adequately proven. Front-end design tools should be tested and used wherever possible even if not uniformly throughout the development organization.

  - At a minimum these design tools will improve the quality of the design and will leave a documentation trail that has long been neglected.

  - In general they will improve the IS/user interaction and will tighten the discipline of the design process.

  - Back-end tools carry a higher investment. Be sure some of the front-end challenges have been conquered before making this key investment.

- The 1990s will bring significant change to the development function and information systems in general. Without a doubt the culture of the development process will go through significant changes. Information systems management is urged to foster the change.

  - The best path to success is by managing that change, not waiting for it to happen.

  - CASE offers a tool to help accomplish and benefit from this change. Use it a a means to progress.

- Today's applications are often of immense complexity and serve multiple users. The old design-as-you-go approach no longer works. It is time systems development matures to a disciplined process. Adopt a solid methodology and gain the discipline of an engineering process.

  - If information systems does not take this step it can expect to see more and more development being done by external firms that are already using disciplined methodologies.

  - The problems associated with not using a methodology may finally exceed the problems of actively following one.

- In the past systems analysts have accepted structured analysis and design techniques, but have not uniformly employed them. The front-end tools are easy to use, do much of the drudgery that the developer tried to avoid, and improve systems quality. Try them, you will like them!

- The maintenance and re-engineering aspects of the life cycle are now being addressed by some of the more creative CASE vendors. Seek them out and challenge the vendors to respond to all of information systems needs.

- Since maintenance is such a major element of the development culture, applying elements of CASE to it will quicken acceptance by the development profession.

- Properly applied, the benefits of CASE may show up more quickly in the maintenance and enhancement area than in new development.

• The best way to implement change is to set realistic targets and then measure progress. The same holds true for CASE.

- Take your best project leaders and turn them loose.

- Pick projects that are guaranteed to attract the attention of the development professional. Put CASE on stage for nonbelievers to see.

- Get information systems management more involved and showcase what is being done.

2. Selecting CASE Tools

INPUT recommends the following criteria, as listed in Exhibit VII-2, to information systems management in the selection of current CASE products and vendors.

EXHIBIT VII-2

CHOOSING CASE TOOLS

- Focus on the User Interface to Front-End Tools.

- Test the Level of Integration Among Specification, Design, and Data Modeling Tools.

- Closely Inspect the Breadth of the Central Repository.

- Verify the Level of Integration of the Code Generation Capabilities.

- Examine the Consistency with Which the Methodology is Enforced.

- Match the Project Management Approach to That Currently in Use.

- Look for the Vendor That Can Provide Proven and Full Support.

- The user interface and the level of graphics employed will tell a great deal about the state of development of front-end tools. Is the product truly using the power of today's workstation?

- Verifying that the various tools are all of a common architecture will prevent surprises and the need to start over with a better product. All of the tools do not have to exist, the key is simply that they are integrated, as well as visually compatible.

- The repository will, over time, pay the greatest benefit as it will aid integration and enhancement. Doing a detailed inspection and comparison against a theoretical standard will tell a great deal about the completeness of the underlying concepts of the vendor and the ability to reach the I-CASE target.

- If a code generator is involved a tight interface is the objective. A major productivity gain is the bridge between design tool and code generation, and, if an additional specification (translation) step is required, the possibility for introducing errors exist. Go with the vendor that commits to a tight integration.

- The methodology is the underlying foundation, whether it is your own or the vendors. Your developers are going to be required to follow it. If the tools are inconsistent in how the methodology is presented you can bet your developers will be inconsistent as well.

- Project management is the link between the subprocesses and tools. It must be consistent with the management style of the organization.

- The full cost of CASE includes the training and energy to accomplish the cultural change. Look for vendors that sell you a means to an end not just a set of tools and ones that are willing to truly participate in your program.

C
Vendor Recommendations

INPUT makes the following recommendations, as listed in Exhibit VII-3, to CASE vendors.

- Recognizing the cultural impact of a full CASE implementation on an information systems organization is essential for long-term market success. The cost of buying the technology, although high, will prove to be small compared to the cost of implementation.

  - Too many vendors are currently concentrating on the product and its sale rather than helping with the cultural change process.

EXHIBIT VII-3

MCAS

CASE—VENDOR REQUIREMENTS FOR SUCCESS

- Provide the Support Services to Achieve Full Customer Implementation.

- Serve the Maintenance and the New Development Requirements.

- Strive for a Full Life Cycle Product Line.

- Provide a Full-Function Repository.

- Develop and Maintain an Open Architecture.

- Support Multiple Methodologies.

- Plan for the Next Generation of CASE Users— the End Users.

- Vendors whose products are based on a single methodology have an advantage, but must first convince the buyer to use their specific methodology.

- The vendor who wraps its products in a full service envelope will prove to have the longest life and best customer reputation.

- The user problem can be viewed as two-thirds existing applications and one-third new development. With information systems organizations that are reluctant to jump in, the vendor that provides help in the maintenance area will have a significant lead.

- Vendors that shy away from the maintenance area will eventually suffer.

- The full user will want one CASE vendor; the maintenance aspect can prove to be the deciding factor.

- Information systems management will be betting its job when it decides to adopt CASE on a broad basis. It will want a single company to turn

to for support, not a multiple vendor environment. This need translates into a full life cycle product line—front end, back end and maintenance support.

- If the vendor can't underwrite the entire product spectrum, then it must use alliances.

- Those alliances must be serious joint development partnerships with the ability of the customer to look to one of the partners for full support.

• Key to the final success, as measured by a long-lasting use of CASE by an information systems organization, will be the power of the repository—the ultimate data dictionary.

- The repository must be the primary focus of the internal vendor development activity.

- The industry can not wait for IBM to define the conclusive answer. Some have already started and are encouraged to continue.

- The repository may prove to be the best area to approach the standards question.

• Open architecture is becoming the software byline of the 1990s. CASE vendors will have to adopt it as well.

- Look for opportunities to evolve a base level of standards and support the activity.

- Focus on the repository and the use of SQL as the standard data base language of the 1990s as one basis for standards.

• A balance is required between "we make design tools for any methodology" and "you must use our methodology." Certainly methodology adoption is the first requirement for successful deployment of CASE; yet the vendor that is too tied to its methodology will quickly narrow its market opportunity.

- The better approach will prove to be, "we can help you implement the methodology of choice through our consulting services experience."

• By the early 1990s the end user will be developing a significant portion of the new applications and be faced with maintenance responsibilities. The largest CASE market may prove to be this new generation of systems developers.

- Concentrating on the user interface to the CASE tools will help prepare for this second wave market.

- Hiding as much of the complexity as possible will be key.

94

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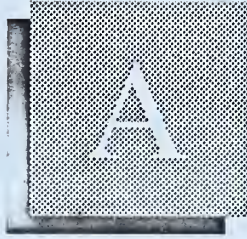
Appendix: Independent CASE Vendor Profiles

BACHMAN INFORMATION SYSTEMS, INC.
Four Cambridge Center
Cambridge, MA 02142-1401
(617) 354-1414

Charles W. Bachman, Chairman
Arnold A. Kraft, President and CEO
Total Employees: 75
Total Revenue, Fiscal Year End
6/30/88: $1,300,000

The Company

Bachman Information Systems, Inc. (BACHMAN) was formed in 1983 by Charles Bachman to develop and market computer-aided software engineering (CASE) products for the maintenance, enhancement, and migration of existing information systems, and for the development of new ones.

- In January 1988, after four years of detailed design and initial development, the company introduced the first products in the BACHMAN/Re-engineering™ Product Set, which will consist of a series of integrated CASE products to support the tasks performed by MIS professionals.

- During product development, BACHMAN has sought the development advice of several large companies - including AEtna Life Insurance, AT&T Commmunications, Bank of Boston, Ernst & Whinney, McDermott Corp., Shearson Lehman Brothers, and UNUM - to develop and test products that address "real-world" business needs.

- BACHMAN management states that its products - unlike most alternatives - are based on how users actually work and do not limit users to a rigid methodology. The BACHMAN/Re-engineering Product Set combines reverse and forward engineering to allow users to begin maintenance, enhancement, or development at any point in the life cycle - at the top, the bottom, or at any point in between - for existing information systems, as well as for new systems development.

BACHMAN is a privately owned company, funded by venture capital firms including Abingworth Management Limited; Atlas Venture, Inc.; Harvard Management; Kleiner Perkins Caufield & Byers; Morgan Stanley Venture Capital; Mayfield Fund; Newmarket Capital Ltd.; Oak Investment Partners; Orien Ventures; Venrock Associates (the venture capital arm of the Rockefeller family trust); and the Vista Group.

BACHMAN's fiscal 1988 revenue of approximately $1.3 million surpassed management's projected results, considering the company's products became commercially available in June of this year.

BACHMAN has recently reached a marketing agreement with IBM. Details of the agreement are not yet available.

BACHMAN currently has approximately 75 employees, segmented as follows:

Marketing/sales	28
Customer support	12
Research and development	26
General and administrative	9
	75

Key Products and Services

One hundred percent of BACHMAN's revenue is derived from its BACHMAN/Re-engineering Product Set family of CASE software products.

The BACHMAN/Re-engineering Product Set includes a family of integrated, modular, graphically presented expert advisor products. Each product advises and assists a different group of MIS professionals working at various phases in the development cycle, with their specific activities. The products treat the development cycle as a flexible set of functions that may be executed, re-executed, or partially executed as needed. Each product contains an expert advisory system and knowledge base of these tasks, derived from industry experts.

- Each of BACHMAN's products operates with the BACHMAN/Workstation Manager™, which runs under MS-DOS on a 386-based PC workstation. The Workstation Manager integrates the expert advisor products and provides basic services and utilities common to all BACHMAN products.

  - The Workstation Manager includes an interactive graphical user interface between the user and expert advisors, session management functions, expert system rule processing, on-line HELP, printing and plotting, and system utilities.

  - The Workstation Manager also provides a personal design data base to store and manage all the components of the users' designs and the Decision Logging™ System, which documents what decisions were made, by whom they were made, when they were made, and why they were made.

- Any number of BACHMAN products can be installed on a single workstation, with all products cooperating through the Workstation Manager, providing full integration and synchronization among products.

- BACHMAN/Workstation Manager has a single-copy price of $5,000.

• In addition to the Workstation Manager, products currently available within the BACHMAN/Re-engineering Product Set include the following:

- BACHMAN/Data Analyst™ (DA) supports information modeling activities, providing graphical tools and expert assistance to create, edit, consolidate, normalize, and validate data base management system (DBMS)-independent Bachman entity-relationship diagrams. These models capture information requirements - they are independent of all implementation details. Other BACHMAN products are then able to define the various uses of this information for data base design. BACHMAN/DA has a single-copy price of $10,000.

- The BACHMAN/Database Administrator (DBA™) product helps data base designers to analyze, design, restructure, edit, report on, redesign, optimize, and migrate exisiting or new data bases.

  • The BACHMAN/DBA (IDMS) allows users to capture existing IDMS schema descriptions and display them as Bachman diagrams. The information can then be edited to meet maintenance requirements, and/or reoptimized for a new set of business operating requirements. Subsequently, the product will create new data description language (DDL) that can be uploaded to the IBM mainframe. BACHMAN/DBA (IDMS) re-engineering capabilities allow it to take a schema description in the design data base and reverse-engineer it into the BACHMAN/DA, or to take the work of the BACHMAN/DA and forward-engineer a portion of or an entire information model to create an IDMS schema with all of the required record, item, and set functions. BACHMAN/DBA (IDMS) has a single-copy price of $10,000.

• Products under development include the following:

- The BACHMAN/DBA (DB2) is tuned to DB2, using DDL, semantic structures, and graphics suitable for DB2 requirements. It captures and generates DB2 DDL, optimizes the DB2 physical structure descriptions, and provides reverse- and forward-engineering capabilities to the BACHMAN/DA (providing expert advisory support for migration into DB2 from other data base or file systems). It also allows users to graphically display and edit existing DB2 schema descriptions. This product is scheduled for availability the first quarter of 1989.

- BACHMAN/DA Capture (Files) can transform conventional file descriptions described in COBOL into information models in the BACHMAN/DA product. Availability is scheduled for the first quarter of 1989.

- BACHMAN/DA Capture (IMS) transforms IMS data base descriptions into information models in the BACHMAN/DA. Availability is scheduled for the first quarter of 1989.

- The BACHMAN/Systems Analyst supports function modeling activities focusing on functional description. It facilitates the creation of data flow diagrams. These diagrams are independent of the physical nature of the process and provide a clear picture of the information flows within the business.

BACHMAN's products require the following configuration:

• Compaq 386, 386/20, 386/25, or IBM PS/2 Model 70 or 80.
• 13-16 megabytes of RAM memory.
• Moniterm 19" monochrome or IBM 8514 16" color display.
• 2-Button Microsoft compatible or IBM mouse.
• MS-DOS (PC-DOS) 3.1 or higher.

Customer support services provided by BACHMAN include a telephone hotline and optional on-site installation, implementation, electronic bulletin board, user meetings, training, and advanced workshops.

Industry Markets   Bachman's products are targeted to the financial services, insurance, telecommunications, and utilities industry sectors.

**Geographic
Markets**

One hundred percent of BACHMAN's fiscal 1988 revenue was derived from the U.S.

In addition to its headquarters in Cambridge, the company has offices in Reston (VA), Schaumberg (IL), New York (NY), Beechwood (OH), and Walnut Creek (CA).

The company is currently developing sales channels throughout Western Europe.

CADRE TECHNOLOGIES INC.
222 Richmond Street
Providence, RI 02903
(401) 351-5950

Louis J. Mazzucchelli, Chairman
David Banks, President and CEO
Private Corporation
Total Employees: 100 (11/88)
Total Revenue, Fiscal Year End
12/31/87: $7,000,000*

*INPUT estimate

The Company

Cadre Technologies Inc., founded in 1982 by Louis Mazzucchelli, Read Fleming, and Kenneth Dill, provides a family of computer-aided software engineering (CASE) tools for software and systems engineers. The company's Teamwork^R product family integrates interactive graphics, system development methodologies, computer-aided design, and high-performance networked workstations to provide increased productivity and quality in development environments.

Cadre's marketing strategy focuses on organizations currently using manual structured techniques in embedded systems market areas such as aerospace, telecommunications, and engineering, and business systems application development. Cadre's products are available through a variety of distribution channels, including telemarketing, direct sales, OEMs, and VARs.

INPUT estimates Cadre's 1987 revenue reached $7 million. Cadre management projects that 1988 revenue will more than double over 1987 levels.

In January 1987 Cadre purchased Structsoft Inc.'s Personal Computer Structured Analysis (PCSA) microcomputer-based structured analysis tool. The technology was used to develop Cadre's Teamwork/PCSA structured analysis software tool for IBM and compatible microcomputers.

Cadre has entered into various alliances/marketing agreements, as follows:

- In August 1988, Cadre announced a value-added reseller agreement with Relational Technology Inc. Cadre's Teamwork family of CASE tools will be tightly integrated with Relational Technology's INGRES family of data base products.

- The contract, worth more than $11 million to Cadre over five years, is targeted to application developers in government, manufacturing, engineering, and DP/MIS, and allows Relational Technology to sell the new integrated INGRES-Teamwork product directly to new customers and its current installed base worldwide.

- The products will be integrated in several phases. The first phase, to be available in the first quarter of 1989, will integrate Teamworks' information modeling tools with the INGRES data dictionary.

• In May 1988, Cadre announced that it had signed MicroCASE, Inc. as a value-added reller of its Teamwork family of products. As part of the agreement, Cadre's Teamwork product will be integrated with MicroCASE's Software Analysis Workstation to address the full life cycle of embedded microprocessor development. Cadre expects to generate more than $3 million in revenue over the next three years through this channel.

• In 1987, Cadre and Pansophic Systems entered into a joint marketing and development agreement to integrate Teamwork's front-end tools with Pansophic's TELON application generator. The product is scheduled for availability in the first quarter of 1989.

• In the fall of 1987, Cadre signed a joint development and marketing agreement with General Electric Corporate Research and Development (GE) to work on an advanced set of Ada development tools based on GE's Interactive Systems Designers Workstation research.

• Since 1986, Hewlett Packard has been an OEM for Teamwork.

Key Products and Services

One hundred percent of Cadre's revenue is derived from software product licenses, associated support services, training, and consulting.

Cadre's Teamwork product family offers a complete environment for systems development that provides model creation and editing, support for large project teams through a shared data base, interfaces to other CASE tools, and easily produced, high-quality documentation. There are currently over 3,500 Cadre Teamwork systems installed worldwide.

Cadre's multi-user, workstation-based Teamwork family of tools run on all standard workstation platforms from Apollo, DEC, HP, IBM, and Sun. The product family includes the following components:

- Teamwork Analysis Tools support both functional and object-oriented requirements analysis and include the following:

  - Teamwork/SA^R, an environment for system analysis, uses data flow diagrams to create and verify functional system specifications.

  - Teamwork/RT^R, an environment for real-time modeling, is an extension to Teamwork/SA. Teamwork/RT allows analysts to model the complexities of real-time systems, including real-time sequencing, timing, and control.

    - Teamwork/ES^{TM} is a prototype that builds on Teamwork/RT's multi-user environment for creating system models, adding a simulation compiler, an interactive execution environment of the compiled models, reachability analysis, and transcription function for test plan generation and regression testing.

  - Teamwork/IM^{TM}, an environment for information modeling, uses entity relationship diagrams to model entities, relationships, and attributes of complex information, and information flows.

- Teamwork Design Tools, for the design of large software systems, follow structured analysis and include the following:

  - Teamwork/SD^{TM}, an environment for systems design, uses structure charts to graphically capture module and sub-routine details required for traditional coding.

  - Teamwork/ADA^{TM} is an Ada system design capture, navigation, and documentation tool. It supports Object-Oriented Design (OOD) techniques and Ada Structured Graph (ASG) notation.

- The Teamwork/IPSE_toolkit^{TM} provides tools, supported by Teamwork's open architecture, that allow users to completely customize and extend the Teamwork development environment. Components include the following:

- Teamwork/DPI™ automated documentation of Teamwork Analysis and Design model objects using Interleaf, Scribe, and VAX Document workstation publishing systems.

- Teamwork/User Menus™ build custom menus on any Teamwork window to execute host text editors, compilers, utilities, and other software tools.

- Teamwork/InterCASE File Import provides standard ASCII file input of both text and graphics from any CASE development system supporting the proposed standard.

- Teamwork/ACCESS™ opens the Teamwork project data base to allow integration of the Teamwork front-end analysis and design tools with third-party back-end documentation, project management, and software development systems.

- In May 1988, Cadre announced a new licensing structure for its workstation-based Teamwork products that allows customers to purchase Teamwork based on the number of simultaneous users they wish to support on the network, rather than the number of workstations they own. Pricing ranges from $7,500 to $15,900 for single-quantity purchases.

In July 1988 Cadre announced the availability of Teamwork for OS/2 environments.

- The integrated single-user Teamwork for OS/2, a bundled product containing Teamwork/SA, Teamwork/IM, and Teamwork/SD, is available for $4,995.

- Cadre also announced a limited offer to users of DOS-based CASE tools to receive a second copy of Teamwork for OS/2 for free by sending to Cadre the security key of their existing tools. The offer is designed to allow users who are migrating to the OS/2 environment a way to salvage their investment in their existing DOS-based tools.

- A multi-user, OS/2 version of Teamwork is scheduled for availability in early 1989.

Teamwork/PSCA™, purchased in January 1987 from Structsoft, is a single-user structured analysis software tool for IBM PC, XT, AT, and compatible microcomputers running PC-DOS or MS-DOS 2.0 or higher, or IBM PS/2 runnning DOS.

- Teamwork/PSCA supports Yourdon/DeMarco Structured Analysis techniques. Data flow diagrams built with

Teamwork/PSCA's Intelligent Graphics Editor help analysts model the system requirements, then maintain and update those models during program design, coding, and onward.

- Teamwork/PSCA models may be transferred to other Teamwork systems for additional analysis, real-time information modeling, distributed analysis and design, automatic document production, and code generation.

- Teamwork/PSCA is priced at $995. There are over 1,500 copies of Teamwork/PSCA installed.

- In September 1988 Cadre and Prentice-Hall announced an agreement to jointly develop a computer-aided workbook for students of CASE technology using Teamwork/PSCA.

Support services provided by Cadre include installation, on-site and centralized training, consulting, documentation, and hotline support.

Industry Markets

Target markets for Cadre's software products include aerospace, telecommunications, and engineering firms involved in embedded systems development, as well as corporations involved in business systems application development.

Geographic Markets

It is estimated that approximately 80% of Cadre's 1987 revenue was derived from the U.S. and 20% from international sources.

Cadre is headquartered in Providence (RI). The company also has nine sales offices located in Providence, Dallas (TX), Foster City and Newport Beach (CA), Orlando (FL), Arlington (VA), Freehold (NJ), Seattle (WA), and Chicago (IL).

Cadre's international subsidiary, Cadre Technologies SA, is headquartered in Switzerland. This unit markets Cadre's products through 13 distributors in 11 European countries.

Cadre also has distributors in Japan and Australia.

COMPANY PROFILE

CORTEX CORPORATION
138 Technology Drive
Waltham, MA 02154
(617) 894-7000

Craig Hill, Chairman
Stuart J. Miller, President and CEO
Private Corporation
Total Employees: 125
Total Revenue, Fiscal Year End
6/30/88: $7,000,000

The Company

Cortex Corporation specializes in building integrated application development tools to increase the productivity of software developers in the DEC VAX environment.

- Cortex was founded in 1977 by Craig Hill and Richard Bertold to provide contract programming and consulting services. These services were provided using the company's own fourth-generation language, Builder.

- In 1981, Cortex made a strategic decision to enter the computer-aided software engineering (CASE) product market by developing a product that would make manual programming obsolete.

- In March 1984, Cortex introduced its first commercially available CASE product, Application Factory™, the industry's first application generator for DEC VAX/VMS environments.

- In September 1987, Cortex introduced CorVision™, an integrated CASE application development system for DEC VAX/VMS environments based on the company's Builder fourth-generation language and Application Factory application generator technologies. CorVision provides complete, transparent integration of a pictorial design and specification capability with automated code and documentation generation.

Self-funded for its first 10 years, Cortex received its first venture financing during 1987. Five venture captial firms invested in Cortex: InnoVen, Xerox Venture Capital, Accel Partners, Schroder Venture Managers, and Regional Financial Enterprises.

Cortex's fiscal 1988 revenue reached an estimated $7 million, a 40% increase over fiscal 1987 revenue of $5 million.

During 1987, Cortex signed two multimillion-dollar development contracts, as follows:

- Under a contract with NCR Corporation, Cortex is porting CorVision to three NCR product lines. NCR will market these versions with their hardware under the CorVision name.

- Under an agreement with E. I. DuPont & Co., DuPont will receive licenses to existing and future Cortex products in exchange for DuPont funding. The funding will be used for product enhancements and new-product development.

Cortex management believes that the company has no competition since there are currently no other vendors offering similar products for the DEC VAX environment.

Key Products and Services

One hundred percent of Cortex's fiscal 1988 revenue was derived from the company's CorVision software products and associated support services.

CorVision, introduced in September 1987, automatically generates production applications for DEC VAX computers directly from design diagrams and specifications. The product, which supercedes Cortex's Application Factory, automates most of the application software life cycle, including design, programming, testing, integration, implementation, and maintenance.

- Using an IBM PC/AT-compatible workstation linked to a DEC VAX, the developer uses CorVision's Picture Progamming™ system to create a visual representation of an application with icons, symbols, pop-up menus, and windows.

- Data dictionary entries, file structures, menus, screens, reports, and logic are all graphically designed at the workstation. Simultanteously, the design specifications stored in a central repository on the VAX are updated from the diagrams, and can therefore be shared by all members of the development team. Throughout the design process, the Intelligent Guidance System serves as an interactive advisor, recommending the next logical step in design and specification, and constantly checking for completeness and consistency.

- Design specifications are then translated into a completely linked and compiled language for the DEC VAX. Because CorVision has the ability to capture the logical meaning of the

diagrams created at the workstation, it is able to drive the integrated VAX-based applications generator directly. System documentation is automatically generated at the same time, all from the drawings.

- Applications built with CorVision use DEC's standard RMS file system or Rdb, DEC's relational data base. They also support VAX clusters and standard VMS data types and languages.

- CorVision automatically generates 95-98% of the application in compiled machine code, as well as complete system documentation. Developers can add the remaining 2-5% of code with Cortex's Builder or with any native VAX third-generation language.

- Applications are also maintained using Picture Programming. The developer modifies diagrams to reflect new requirements that simultaneously update the design and specifications stored in the central repository. CorVision then regenerates the affected parts of the code and data structure, producing a newly compiled, linked, and documented application.

CorVision is priced from $55,000 for an entry-level DEC VAX system. A 90-day warranty is provided with each license. Thereafter, annual maintenance contracts are available for 12.5% to 15% of the purchase price.

There are currently approximately 500 Cortex product licenses worldwide (200 development and 300 run-time).

Building on its "bottom-up" approach to software development tools, Cortex is currently developing products that address the areas of strategic system planning and systems analysis.

Industry Markets   The target market for Cortex's products is large corporations with DEC VAX systems installed. The company has been especially successful in marketing its products to the process manufacturing industry.

Cortex clients include DuPont, PepsiCo, Eastman Kodak, General Electric, Chemical Bank, Price Waterhouse, and Lloyds Bank.

Geographic Markets   An estimated 60% of Cortex's fiscal 1988 revenue was derived from the U.S. and 40% from international sources.

Cortex has U.S. sales offices in Atlanta, Cleveland, Dallas, Detroit, Los Angeles, New York, San Francisco, and Washington, D.C.

Cortex's wholly owned subsidiary, Cortex Ltd., is headquartered in Bristol (England). Cortex's products are available throughout Western Europe, Australia, and Bermuda.

HOLLAND SYSTEMS CORPORATION
Suite 303
3131 South State Street
Ann Arbor, MI 48108
(313) 995-9595

Dr. Robert H. Holland, Chairman and President
Private Corporation
Total Employees: 40 (11/88)
Total Revenue, Fiscal Year End
12/31/87: $2,200,000

The Company

Holland Systems Corporation, founded in 1981 by Robert H. Holland, develops and markets a series of computer-aided systems engineering (CASE) tools based on the information resource management and systems development methodologies of the company's founder. Dr. Holland formerly was the President of Database Design Inc., which is now known as KnowledgeWare.

- In support of its CASE products, Holland Systems provides education and training and consulting professional services to its clients.

Holland Systems considers itself a marketer of a structured and disciplined methodology for the development of complex application systems and systems environments. The software products that it develops and markets are all based on these methodologies, and successful use requires that the purchaser adopt the Holland methodology.

- Holland does not refer to itself as a CASE vendor, but as a vendor of information resource management (IRM) tools. The products start at the very top of the systems architecture process and address the entire management, analysis, design, and implementation process.

- The top-level product, 4FRONT*strategy*, is mainframe based and addresses the overall IRM process. Thus it is applied to the entire information systems environment, not just one or more projects and systems.

- Certain of Holland Systems' products use customized versions of Index Technology's Excelerator systems analysis and design tools.

Holland Systems' 1987 revenue was approximately $2.2 million, a 60% increase over estimated 1986 revenue of $1.3 million. It is estimated that 1988 revenue will increase 60% over 1987 levels. Management attributes the company's growth to an expanded product line and marketing support from Deloitte Haskins & Sells.

Holland Systems has an alliance with Deloitte Haskins & Sells (DH&S), under which DH&S uses Holland methodologies and products in its information systems consulting business. The two companies are jointly developing products to add to the Holland Systems product line. DH&S also has nonexclusive marketing rights to relicense Holland Systems' products to DH&S clients.

In August 1988, James R. Drenning was named Chief Operating Officer.

Major competitors include Texas Instruments, KnowledgeWare, Arthur Andersen, and Dacom.

Key Products and Services

Approximately 75% of Holland Systems' revenue is derived from methodology and software product licenses. The remaining 25% of revenue is derived from education and training and consulting professional services provided in support of the company's product line.

Holland Systems' product line consists of the following:

- 4FRONT*strategy* provides a tool for clarifying business direction and embedding the related information needs into an information resource management plan and architecture that support a corporate vision through integrated information systems.

  - The use of 4FRONT*strategy* results in a function model, an organization model, a data architecture, an application architecture, and a project plan that can be maintained dynamically to build an integrated approach to information resource management.

  - The product is mainframe based and sells for $95,000. A 4FRONT*strategy* micro option product exists that permits much of the strategy modeling to be developed on a PC and then up-loaded to the mainframe system. The PC product is a customized version of Index Technology's Excelerator and costs $9,500.

- There are currently approximately 65 installations of 4FRONT*strategy*.

• 4FRONT*planner* is a procedural methodology and software tool designed to assess the implementation of the architectures proposed by 4FRONT*strategy*. This product serves as the bridge between the planning and the actual systems development and implementation.

  - 4FRONT*planner* is priced at $20,000.

  - There are currently approximately 10 installations of 4FRONT*planner*.

• *Design4applications* provides a structured approach to the application development process. This is the tool that supports the actual application logical design process.

  - The output of *Design4applications* is a function design specification covering the applications characteristics from the user and technical points of view.

  - *Design4applications* is a PC-based product that includes Index Technology's Excelerator. It is priced at $25,000.

  - There are currently five installations of *Design4applications*.

• *Design4data* provides a "comprehensive solution for logical database design." By building upon the models developed by 4FRONT*strategy*, this member of the Holland family of tools assures that the evolving data architecture is implemented in an efficient and integrated fashion.

  - *Design4data* is mainframe-based, is easily linked to 4FRONT*strategy*, and sells for $45,000.

  - There are currently approximately 35 installations of *Design4data*.

• *Build4applications* is a PC-based product that translates the functional design developed by *Design4applications* into a detailed design specification ready for programming. This product is also based on Excelerator.

  - *Build4applications* is priced at $22,000.

  - There are currently approximately five installations of *Build4applications*.

- 4FRONT*implementer* provides a structured methodology and control system to guide the implementation of an information system into a production environment. This product helps plan the implementation, train the user, perform testing, and place the system into production.

  - 4FRONT*implementer* is priced at $15,000 for a perpetual, single "Integrated business" license.

  - There are currently approximately five installations of 4FRONT*implementer*.

- 4FRONT*manager* is a project management system designed to track the entire utilization of 4FRONT products and methodologies throughout the information systems development process.

  - 4FRONT*manager* is based on Project Workbench^R from Applied Business Technology Corp. and sells for $1,500.

  - There are currently two installations of 4FRONT*manager*.

- *Build4data* is a product that is currently under development. The product will provide a methodology and supporting software to transform the logical data model from *Design4data* into a physical data base implementation.

In addition to hotline services, all of Holland Systems' products and methodologies are supported by consulting services and a series of public and private training seminars. These support services, as do the software tools, start at the strategic level and descend to the implementation level.

- Holland Systems firmly believes that professional support of its methodologies is a critical element to their successful deployment.

- For example, the purchase of 4FRONT*strategy* includes 15 days of education and consulting support.

Holland Systems products currently do not interface to any of the Application Code Generation products that are referred to as "lower" or "back end" CASE tools.

Industry Markets   Holland Systems' target market for its products and services includes Fortune 500 corporations and large government information systems organizations.

                   November 1988

Clients include Aetna Life and Casualty, American Express, the U.S. Comptroller of the Currency, General Dynamics, Hertz Corporation, Squibb Corporation, and TransWorld Airlines.

Geographic Markets

The majority of Holland Systems' revenue is derived from the U.S. and Canada.

In addition to its headquarters office in Ann Arbor, Holland Systems has sales offices in Milwaukee and California.

Holland Systems' products are available worldwide through Deloitte Haskins & Sells' international consulting organization.

**INDEX TECHNOLOGY
CORPORATION**
One Main Street
Cambridge, MA 02142
(617) 494-8200

Richard A. Carpenter, President and CEO
Public Corporation, OTC
Total Employees: 230 (11/88)
Total Revenue, Fiscal Year End
  12/31/87: $21,963,000

The Company

Index Technology Corporation, founded in 1983, develops and markets a family of computer-aided software engineering (CASE) products for systems analysts and designers in various industries. Index also offers software maintenance, training, and implementation support services to its clients.

The company's strategy is to provide a family of CASE products and services to support the entire systems development process. This strategy is based on the following elements:

- Open Architecture: The open architecture of Index Technology's Excelerator[R] allows customers to support their chosen development methodologies and allows Excelerator to be linked with other systems, applications, and development software. Excelerator interfaces with a range of back-end CASE products, including code generators, fourth-generation languages, and traditional programming languages.

- Portability: Excelerator operates on the full range of IBM microcomputers and compatibles, as well as workstations from DEC, Apollo, and Sun Microsystems. The user interface and design dictionary are consistent across all supported hardware, allowing customers to use Excelerator in heterogeneous computing environments.

- Customization: Index Technology's products are built on "Base Excelerator", a core technology that incorporates an integrated and extensible dictionary that allows development of Excelerator packages for different applications. Additional Index Technology products allow customers and third parties to develop interfaces with Excelerator/IS, Excelerator/RTS, and other customized Excelerator packages.

- Customer Support Services: The company provides training, consulting on CASE implementation issues, and product support services.

In June 1988, Index made an initial public offering of 1.6 million shares of its common stock. Net proceeds of approximately $14.7 will be used for general corporate purposes.

Index Technology's 1987 revenue reached nearly $22 million, a 45% increase over 1986 revenue of $15.1 million. Net income rose 5%, from $2.2 million in 1986, to $2.3 million in 1987. A four-year financial summary follows:

INDEX TECHNOLOGY CORPORATION
FOUR-YEAR FINANCIAL SUMMARY
($ thousands, except per share data)

	FISCAL YEAR			
ITEM	1987	1986	1985	1984
Revenue • Percent increase from previous year	$21,963 45%	$15,142 51%	$10,020 503%	$1,663 *
Income (loss) before taxes and extraordinary items • Percent increase from previous year	$4,054 36%	$2,975 131%	$1,290 *	$(1,904) *
Net income (loss) • Percent increase from previous year	$2,262 5%	$2,164 (a) 75%	$1,239 (a) *	$(1,904) *
Earnings (loss) per share • Percent increase from previous year	$0.70 --	$0.70 (a) 52%	$0.46 (a) *	$(1.53) *

* *Percent change not meaningful.*

(a) *Includes a tax benefit from utilization of loss and foreign tax credit carryforwards of $428,000, or $0.14 per share, for 1986, and $677,000, or $0.25 per share, for 1985.*

Research and development expenditures, net of software capitalization, were approximately $5.2 million (24% of revenue) in 1987, $2.8 million (19% of revenue) in 1986, and $1.3 million (13% of revenue) in 1985.

Index Technology management attributes revenue growth to increases in the number of units licensed and related increases in maintenance and customer training revenue.

 November 1988

Revenue for the nine months ending September 30, 1988 reached $20.8 million, a 35% increase over $15.5 million for the same period in 1987. Net income rose 8%, from $1.6 million to $1.75 million.

During 1986, Index Technology purchased 19% of the common stock of DeltaCom, Inc. for $95,000 and in 1987 acquired the remaining outstanding stock of DeltaCom for $200,000 in cash, $405,000 in notes, plus guaranteed minimum future royalties. The acquisition was for purposes of obtaining certain software products, principally PC Prism, a microcomputer-based strategic systems planning product.

In addition to direct sales, Index Technology has cooperative marketing relationships with DEC, Sun Microsystems, and Apollo Computer.

- IBM makes Excelerator available through its domestic sales force under its Vendor Logo Program.

- Index Technology has value-added reseller agreements with AGS Management Systems, American Management Systems, Cincom, DACOM, Cap Sogeti Instruments, Holland Systems, Texas Instruments, and Italsiel S.p.a.

- The company also encourages the development of packages based on Excelerator by third parties through its Package Developer Program.

As of December 31, 1987, Index Technology employed 186 persons. Currently there are 230 employees.

Major competitors include Nastec, KnowledgeWare, Texas Instruments, and Cadre Technologies.

Key Products and Services

Index Technology derives 100% of its revenue from its CASE software products and related services. Currently, approximately 87% of revenue is derived from software licenses, 9% from maintenance services, and 4% from implementation support.

A three-year historical summary of source of revenue follows:

INDEX TECHNOLOGY CORPORATION
THREE-YEAR SOURCE OF REVENUE SUMMARY
($ thousands)

ITEM	FISCAL YEAR					
	1987		1986		1985	
	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL
Software licenses	$19,215	87%	$13,953	92%	$9,734	97%
Maintenance and training	2,748	13%	1,189	8%	286	3%
TOTAL	$21,963	100%	$15,142	100%	$10,020	100%

Excelerator offers tools to support the systems analysis, design, and documentation process.

- Base Excelerator facilities include graphics for the development, modification, and printing of diagrams; data base edit/query; reporting and advanced rule-based analyses; screen and report design; prototyping; documentation production; data sharing; an interface facility that enables the transfer of data between the dictionary and other products or languages; and a central dictionary that integrates the program's functions and provides cross-referencing and cross-checking analysis capabilities.

- Excelerator provides support for multiple users on a variety of local area networks, including PC LAN (IBM), 3COM (3COM Corporation), NetWare 286 (Novell, Inc.), and STARLAN (AT&T).

- Index Technology and third parties have developed links between Excelerator and a variety of back-end CASE products, including COBOL/2 Workbench (Micro Focus, Ltd.), TELON (Pansophic Systems), POWERHOUSE (Cognos Incorporated), MAGEC (Al Lee & Associates), and APS (Sage Software). These interfaces enable systems developers to design their systems, screens, and reports on Excelerator and then transfer them to an applications generator for the generation of code.

- Excelerator runs on IBM PS/2, PC/AT, PC/XT, and compatibles, and on DEC VAXstations, and Sun and Apollo workstations.

- Excelerator/IS provides support for software and systems development techniques most widely used for design of commercial MIS systems, which are typically written in COBOL.

  - Customers use Excelerator/IS to design a variety of applications, including personnel management, order entry, production scheduling, inventory control, and sales analysis.

  - Excelerator/IS provides all of Base Excelerator's facilities together with specific support for transaction-based and data base-oriented systems. The analysis capabilities of Excelerator/IS provide support specifically for data and process modelling and for the development of user-defined reports.

  - Excelerator/IS can also interface to various commercial data base management and data dictionary products, including IMS/DBDC and DB2 (IBM), ORACLE (Oracle Corporation), and dBASE III (Ashton-Tate).

  - Excelerator/IS is priced at $8,400. There are approximately 10,000 installations worldwide.

- Excelerator/RTS™ is tailored to meet the requirements of organizations which design, develop, and document real-time (including embedded) systems, such as avionics, manufacturing process control, and communications systems.

  - Excelerator/RTS was designed and developed by Index Technology in 1986 in conjunction with six of its customers: The Boeing Company, Texas Instruments, Hughes Aircraft, Sperry Corporation, Northern Telecom Limited, and Rexnord Automation.

  - Excelerator/RTS provides all of Base Excelerator's dictionary, graphics, analysis, reporting, and documentation facilities, with specific support for structured techniques and languages required in this market, including the Ward-Mellor and Hatley techniques.

  - Excelerator/RTS is priced at $8,400. Currently there are approximately 2,000 installations.

Customization products offered by Index Technology, used to create new versions of Excelerator to meet the requirements of specific markets, include the following:

- Customizer™ enables organizations to integrate Excelerator with their own approaches to develop custom software and systems.

  - Customizer is used to modify facilities and menus, customize dictionary entities and attributes, customize graphics techniques, establish calls to interface programs and custom analysis programs, and incorporate specific documentation standards or templates.

  - Customizer runs on IBM PC/XT, PC/AT, and compatibles, DEC VAXstations, and Sun and Apollo workstations.

  - Customizer is priced at $12,500. There are 150 Customizer installations.

- XL/Programmer Interface™ (XL/PI) is a utility that directly accesses Excelerator's data dictionary and graphics file for communicating with mainframe data dictionaries, application generators, fourth generation languages, and custom analysis routines. XL/PI is included in Customizer. or may be licensed separately for $995.

- Using Customizer and XL/PI, Index Technology has developed interfaces with products such as PageMaker (Aldus Corporation), Technical Publishing Software (Interleaf), Ventura Publisher (Ventura Software), and Project Workbench (Applied Business Technologies).

Complementary products provided by Index Technology include the following:

- PC Prism™ can be used alone or with Excelerator/IS to create systems and high-level data models for evaluating system requirements prior to design.

  - Data stored in PC Prism may be automatically transferred to Excelerator to start the software and systems design with the appropriate corporate data and process information.

  - The first copy of PC Prism, which allows the user organization to define the structure of the PC Prism data base, is available for $8,000. Subsequent copies are available for $4,250. There are currently 300 PC Prism installations.

- XL/Design Integrator™ (XL/DI) integrates on DEC VAX and MicroVAX III minicomputers the work of individual Excelerator users from multiple workstations. XL/DI ranges in

price from $10,000 to $40,000, based on the maximum number of simultaneous users.

- PSAM (formerly VDAM) is a microcomputer-to-mainframe link that allows Excelerator users to store and share data on IBM mainframes operating under MVS. PSAM is owned by Phaser Systems, Inc. and is distributed by Index Technology on a non-exclusive basis. PSAM ranges from $9,000 to $50,000, depending on the maximum number of simultaneous users.

Index Technology's products are covered by a 90-day warranty which includes telephone hotline access, field support, and periodic product updates. Index Technology provides maintenance and support of Excelerator for an annual fee which is currently 12% of the license fee. Volume license and maintenance programs are available.

Customer support services provided by Index Technology include the following:

- Index Technology offers a variety of training courses for its products as well as for implementing structured analysis and design techniques. During 1987, more than 1,700 individuals participated in courses offered by the company.

- The company also provides planning, implementation, customization, and specialized training services to its customers on a fixed-fee basis.

Industry Markets   Index Technology's target markets include industries with heavy information handling needs, such as insurance, communications, transportation, and financial services firms, as well as organizations with large staffs of systems analysts, such as high technology manufacturers, consulting firms, and contract programming firms.

Index Technology currently has approximately 1,200 customers, including more than 200 of the Fortune 1000 companies, five of the ten largest computer hardware manufacturers in the U.S., and four of the Big Eight accounting firms.

Major clients include AT&T, Shell Oil, IBM, Hewlett Packard, and J.C. Penney.

Geographic Markets

Approximately 74% of Index Technology's 1987 revenue was derived from the U.S. The remaining 26% was derived from foreign sources, including the U.K., Canada, and Europe.

A three-year summary of geographic source of revenue follows:

INDEX TECHNOLOGY CORPORATION
THREE-YEAR GEOGRAPHIC SOURCE OF REVENUE SUMMARY
($ thousands)

| | FISCAL YEAR | | | | | |
| | 1987 | | 1986 | | 1985 | |
ITEM	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL
U.S.	$16,347	74%	$11,860	78%	$8,574	86%
International	5,616	26%	3,282	22%	1,446	14%
TOTAL	**$21,963**	**100%**	**$15,142**	**100%**	**$10,020**	**100%**

Index Technology sales offices are located in Georgia, New Jersey, Virginia, Massachusetts, Illinois, Michigan, Missouri, Texas, California, and Connecticut.

The company's European headquarters is located in Herfordshire, England. Index Technology also has international offices in Canada and Australia and its products are available through a network of distributors in more than 25 countries.

Computer Hardware

Index Technology has the following computers installed at its headquarters in Cambridge:

- 2 DEC MicroVAXs.
- 10 DEC VAXstations.
- 30 Apollo workstations.
- 8 Sun workstations.
- Over 230 IBM microcomputers.

 November 1988

KNOWLEDGEWARE, INC.
3340 Peachtree Road, N.E.
Suite 1100
Atlanta, GA 30026
(404) 231-8575

Fran Tarkenton, Chairman and CEO
Terry McGowan, President
Private Corporation
Total Employees: 130 (10/88)
Total Revenue, Fiscal Year End
6/30/88: $15,000,000

The Company

KnowledgeWare, Inc. develops and markets computer-aided software engineering (CASE) tools that automate information systems development. KnowledgeWare's tools are used by corporations and government agencies to help data processing professionals automate the planning, analysis, design, construction, and maintenance of information systems using different methodologies and techniques, including Information Engineering, Yourdon, and DeMarco, among others.

- KnowledgeWare was founded in 1979 as Database Design, Inc. by James Martin. The company changed its name to KnowledgeWare, Inc. in December 1985.

- KnowledgeWare merged with Tarkenton Software, Inc. in December 1986.

Total fiscal 1988 revenue reached $15 million, a 36% increase over fiscal 1987 revenue of $11 million. Software product revenue actually increased 94% in fiscal 1988. The company reported a profit for fiscal 1988. A three-year revenue summary follows:

KNOWLEDGEWARE, INC.
THREE-YEAR REVENUE SUMMARY
($ millions)

	FISCAL YEAR		
ITEM	6/88	6/87	6/86
Revenue • Percent increase from previous year	$15.0 36%	$11.0 80%	$6.0 224%

KnowledgeWare management projects an 80% growth rate in fiscal 1989.

As of June 1988, KnowledgeWare had approximately 110 employees. As of Ocotober 1988, the company had approximately 130 employees, segmented as follows:

Marketing/sales	60
Product development and customer support	52
Administrative and executive	<u>18</u>
	130

Key Products and Services

Approximately 80% of KnowledgeWare's fiscal 1988 revenue was derived from systems software product sales. The remaining 20% was derived from associated training and maintenance services.

KnowledgeWare microcomputer-based software products include the following:

- Information Engineering Workbench^R/Planning Workstation (IEW/PWS) is a microcomputer-based set of diagrammatic tools that support the planning phase of information systems development.

  - IEW/PWS uses tightly integrated diagrams , including decomposition diagrams, entity diagrams, and tables or matrices to capture and analyze planning information such as business functions, data, goals, and candidate projects. The planning information captured using the diagrams is kept in a common, intelligent Encyclopedia that is shared with KnowledgeWare's Analysis and Design Workstations. Working with the Encyclopedia is the Knowledge Coordinatior, a rules-based system that provides real-time error checking to ensure the consistency of information collected.

  - IEW/PWS was first installed in December 1987, and there are over 2,000 current users. The purchase price is $8,625.

- Information Engineering Workbench/Analysis Workstation (IEW/AWS) is a microcomputer-based set of diagrammatic tools that support the analysis phase of information systems development.

- IEW/AWS contains tightly integrated diagramming tools, including the Decomposition Diagrammer, Entity Diagrammer, and Action Diagrammer. The knowledge captured using the diagrams is kept in a common, intelligent Encyclopedia that is shared with KnowledgeWare's Planning and Design Workstations. The Encyclopedia works with the Knowledge Coordinator.

- IEW/AWS was first installed in November 1985, and there are over 4,500 current users. The purchase price is $8,625.

• Information Engineering Workbench/Design Workstation (IEW/DWS) is a microcomputer-based set of diagrammatic tools that support the design phase of information systems development.

- IEW/DWS is composed of commonly used, tightly integrated design diagrams, including structure charts, data structure diagrams, presentation diagrams for screen design, and action diagrams for modules. The knowledge captured using the diagrams is kept in the Encyclopedia that is shared with KnowledgeWare's Planning and Analysis Workstations. The Knowledge Coordinator works with the Encyclopedia.

- IEW/DWS was first installed in December 1987, and there are over 2,500 current users. The purchase price is $8,625.

• A special Starter Kit of all three IEW/Workstation tools (includes one each of Planning, Analysis, and Design) is available for $10,000.

• The above KnowledgeWare microcomputer-based software products run on the IBM PS/2 (Model 50 or above) under DOS 3.3 or higher and the IBM PC/AT and 3270 AT, COMPAQ 286 and COMPAQ 386 or compatibles under DOS 3.1 or higher. Minimum memory on the mother board is 640K with an additional 4Mb of additional memory that includes 2Mb for a virtual disk; Video Graphics Array (VGA), Enhanced or Color Graphics Adapter (EGA or CGA) with a total of 128K; source language is C and Prolog (source code is not available); documentation is included; there is a 90-day warranty.

• Action Diagrammer[R] is a microcomputer-based, full-function, color action diagram editor.

- Action Diagrammer runs on the IBM PC, PC/XT, PC/AT, 3270 PC, and compatibles; PC-DOS operating system (version 2.1 or higher), minimum memory of 256 Kb; source language is C (source code not available); documentation is included; there is a 90-day warranty.

- Action Diagrammer was first installed in December 1984, and there are over 2,200 current users. The purchase price is $495. A demo diskette is available for $25.

KnowledgeWare mainframe-based products include the following:

- Information Engineering Workbench/Mainframe Knowledge Coordinator and Encyclopedia (IEW/MF) is a mainframe-based repository for the microcomputer-based IEW/Workstation tools.

  - IEW/MF allows users of the IEW/Workstation tools to use the security, capacity, and speed of the mainframe to manage the information collected on the microcomputer.

  - In addition to reporting and analysis capabilities, the IEW/MF features shared access, permitting multiple users at one site or several sites, to share a common encyclopedia; project control so work can be divided among project team members and compiled and reconciled in order to handle large project; and faster response time.

  - IEW/MF runs on IBM 370, 3XXX, and 43XX systems using the MVS/SP operating system with the Data Facility Product running TSO extensions, ISPF/PDF and MVS Programming in Logic MVS/Prolog; source language is IBM Prolog (source code not available); documentation included; one-year maintenance is included in the the license fee; both the IBM 3273/79 Emulator Adapter and the IRMA board are supported for micro-to-mainframe file transfer.

  - IEW/MF was first installed in May 1987, and there are over 50 current users. The perpetual license fee is $115,000.

- GAMMA™ is a mainframe-based COBOL applications generator that helps system designers to build screen and report layouts, physical file and data base definitions, menus, and procedural logic.

- GAMMA runs on any IBM or compatible mainframe supporting ANS COBOL and a keyed-access method with the MVS operating system; the minimum memory required is 1,000K virtual storage with 300 cylinders (3350 disk equivalent) auxiliary storage. Its source language is COBOL (source code not available); and it supports a variety of data base management systems and teleprocessing environments; one-year maintenance is included in the license fee.

- GAMMA was first installed in February 1981, and there are over 60 current users. Perpetual license pricing is $209,300 plus a mandatory training package for $20,000.

- Data Designer^R II is a mainframe-based normalization and data base design tool that helps to improve the accessibility of information.

  - It accepts user views of data, combines them using canonical synthesis, then reduces them to the simplest and most nonredundant structure possible.

  - Data Designer II and its various optional modules, including interfaces with several commercial data dictionaries, runs on the IBM 370, 3XXX, and 43XX with the IBM MVS operating system; minimum memory required in 2,500Kb; source language is FORTRAN IV and Assembler (source code not available); documentation is included; one-year maintenance is included in the license fee.

  - Data Designer II was first installed in December 1979, and there are over 280 current users. Perpetual license pricing is $50,600.

- Information Planner^R is a mainframe-based tool that helps capture, organize, update, report on, and analyze data about an organization and its use of information.

  - Information Planner helps to define planning information (such as business functions, business goals, data requirements, how data is currently stored, how business functions are currently performed) and to make recommendations about prioritizing information system development projects, migrating to a shared data base environment, and determining the scope of individual data bases.

- Information Planner runs on IBM 370, 3XXX, and 43XX with the MVS operating system; source language is PL/1 and Assembler (source code not available); documentation is included; one-year maintenance is included in the license fee.

- Information Planner was first installed in November 1983, and there are over 110 current users. Perpetual license fees are $40,250.

- IEW/GAMMA, introduced in the fall of 1988, achieves the true integration of KnowledgeWare's front-end and back-end CASE products. IEW/GAMMA permits the transfer of system designs directly into the GAMMA code generation process. IEW/GAMMA is now being used by existing clients and is available for purchase.

KnowledgeWare provides hotline assistance to its clients between 8:30 a.m. and 5:30 p.m. (EST) weekdays.

KnowledgeWare offers the following training courses in support of its software sales:

- KnowledgeWare Product Courses:

  - Planning Workstation Workshop
  - Analysis Workstation Workshop
  - Design Workstation Workshop
  - Information Planner Tool Application
  - Data Designer II Tool Application
  - GAMMA Design & Programming Workshop
  - GAMMA Design Workshop
  - GAMMA Programming Workshop

- CASE Courses:

  - Survey of Information Engineering Concepts
  - Joint Application Design Workshop
  - Information Strategy Planning
  - Data Analysis

Industry Markets   KnowledgeWare's revenue is derived from across all industry sectors.

       November 1988

**Geographic
Markets**

Approximately 60% of KnowledgeWare's fiscal 1988 revenue was derived from the U.S. and 40% from international sources.

KnowledgeWare has regional sales offices in Ann Arbor (MI), Arlington (VA), Atlanta (GA), Chicago (IL), San Francisco and Newport Beach (CA), Iselin (NJ), Cambridge (MA), Dallas (TX), and St. Louis (MO).

KnowledgeWare's products are distributed outside the U.S. by Arthur Young International affiliate member firms.

LANGUAGE TECHNOLOGY INC.
27 Congress Street
Salem, MA 01970
(508) 741-1507

William Engel, President and CEO
Private Company
Total Employees: 52
Total Revenue, Fiscal Year End
12/31/87: $5,000,000

The Company

Language Technology Inc. was founded in 1981 by Dr. Eric Bush, a pioneer in the field of graph technology and formal language theory. The company provides computer-aided software engineering (CASE) software products and professional services for restructuring and quality analysis of COBOL programs.

- Language Technology commenced operations in 1984 after Dr. Bush overcame the reducibility problem of restructuring COBOL language and spent another three years refining RECODER™, the company's first product.

- RECODER processing was initially available only as a service through Language Technology. In 1985, RECODER became available as a software product for in-house use.

- The company targets the largest IBM mainframe sites worldwide for its products and services.

The company's strategy is to market its software re-engineering products through a direct sales force in the U.S. and distributors in major foreign markets.

Language Technology's 1987 revenue reached approximately $5 million, a 40% increase over 1986 revenue of approximately $3.6 million.

Major competitors include IBM and Peat, Marwick, Main & Mitchell.

Key Products and Services

Approximately 95% of Language Technology's 1987 revenue was derived from software product licenses. The remaining 5% of revenue was derived from professional services involving the restructuring of COBOL code.

Language Technology's RECODER product automatically restructures a COBOL program by understanding the program's control flow and mathematically simplifying it into functionally identical structured COBOL.

- RECODER can automatically recode any COBOL program that is accepted by a compiler, and even some that are not.

- According to industry experts, the structured code produced by RECODER can reduce maintenance costs by 50%.

- RECODER runs on IBM and compatible mainframes under DOS, OS, and VM. The product licenses for between $74,500 and $149,000.

- There are currently 84 clients that have licensed RECODER for in-house use and 150 that have contracted for Language Technology's RECODER service.

INSPECTOR™, introduced in 1986, is a COBOL quality analysis tool. INSPECTOR uses established measurement criteria and provides a customization option that allows the user to measure existing COBOL systems against his own in-house standards for new COBOL code development.

- INSPECTOR runs on IBM and compatible mainframes and is priced from $14,500 to $29,500.

- There are currently 52 clients using INSPECTOR.

Industry Markets

Target markets for Language Technology's products and services include large corporations in the manufacturing, insurance, communications, financial services, and oil industries.

Language Technology clients include Merrill Lynch, Mellon Bank, Federal Express, Hartford Insurance Group, Lockheed, and NYNEX.

Geographic Markets

Approximately 75% of Language Technology's revenue is derived from the U.S. The remaining 25% is derived from international sources.

In addition to its headquarters in Salem, the company has offices in New York, New Jersey, Washington, D.C., Atlanta, Chicago, and Los Angeles.

NASTEC CORPORATION
24681 Northwestern Highway
Southfield, MI 48075
(313) 353-3300

Steve Manz, President
Private Corporation
Total Employees: 120 (11/88)
Total Revenue, Fiscal Year End
12/31/87: $10,000,000*

*INPUT estimate

The Company

Nastec Corporation, founded in 1982, provides computer-aided software engineering (CASE) software products and associated education and consulting support services.

The company's strategy is to provide CASE support across the entire systems development life cycle.

Nastec competitors include KnowledgeWare, Index Technology, and Texas Instruments.

Key Products and Services

INPUT estimates that 90% of Nastec's 1987 revenue was derived from its CASE software licenses and 10% was derived from associated education and consulting support services.

Nastec's CASE 2000 products work together to automate systems development in the areas of requirements cataloging and management; structured analysis and structured design, including real-time system modeling; data modeling and data base design; documentation and document production; and project management and control.

- DesignAid^R is a complete system for structured analysis and system design that automatically checks diagram consistency and supports interactive, multi-user acccess to data dictionaries.

  - DesignAid supports Yourdon/Demarco methodologies and diagramming for structure charts, process flow, flow charts, Nassi-Schneiderman charts, Jackson diagrams, Warnier-Orr, Gane/Sarson, HIPO, and decision tables.

  - Documentation support includes integrated graphics - on screen and in print - and reporting capabilities. Forms, screens, and reports can be prepared using standard or user-defined graphics.

- DesignAid also supports local-area networks for PCs, and DEC's DECnet for VAXstations.

- The DesignAid single license price is $6,900 for IBM PC and compatibles and DEC VAXstation versions. There are currently 8,000 systems installed.

- The DesignAid Data Modeling option provides support for data modeling and entity-relationship diagrams for information systems engineering and data base design. This option is priced at $1,500 and features automatic analysis, consistency checking, and easy error correction.

- The DesignAid Real-Time option supports Ward/Mellor and Hatley diagramming for real-time systems, including state transition diagrams. This option is priced at $1,500 and features automatic analysis and consistency checking of control flows and processes to state transition diagrams.

- Nastec also offers CASE 2000 TELON Interface, an option for DesignAid running in a PC environment to access Pansophic System's TELON application generator running in a mainframe or PC environment. The interface is priced at $9,900 for a site license.

- LifeCycle Manager[R] is an interactive, on-line, project planning and work management system that includes a tailorable life cycle methodology (Project Management Guidelines[R]) and support for commercial or user-specified methodolgies.

  - Project planning features include estimates, risk assessment, schedules, and project planning reports.

  - Work management features include scheduling, assigning and tracking responsibility, and logging project time.

  - A DesignAid interface provides access to a multi-user data base for development schedules, changed priorities, and reporting.

  - LifeCycle Manager is priced from $3,800.

- DesignAid and LifeCycle Manager operate on DEC VAXstation II and 2000 systems, running VAX/VMS Version 4.4 or higher, and IBM PC XT, AT, and compatibles and IBM PS/2 Model 30, 50, 60, 80 systems running PC-DOS or MS-DOS.

- RTrace™ is a DEC VAX-based system for requirements management, analysis, and allocation.

  - RTrace is designed to meet the reporting and requirements tracing for the U.S. Department of Defense DoD-STD 2167A and will also operate with any life cycle methodology for government, civilian, or private industry development.

  - RTrace includes user-defined categories for organization, mapping user requirements to detailed system requirements, and compliance tracing at low levels of detail.

  - RTrace is priced at $30,000.

Nastec's Consulting and Education Division provides a series of educational courses, workshops, and consulting services to assist clients in implementing CASE.

- Courses are available at Nastec's headquarters and at the client's site.

- Nastec has trained over 3,000 developers, consultants, and managers in CASE technology and practical applications worldwide.

Nastec's Technology Transfer Program™, introduced in 1988, combines a customized implementation program, educational courses in CASE, Nastec CASE software products, and consulting services to assist clients in their implementation of CASE. Pricing for the program is based on a combination package of 25 DesignAid licenses and support.

Industry Markets

Nastec's software products are targeted to Fortune 1000 companies.

Clients include American Airlines, RCA, Citibank, Texaco, Ford Aerospace, and the Internal Revenue Service.

**Geographic
Markets**

Nastec is headquartered in Southfield (MI) and has regional sales offices in Cincinnati (OH), Oak Brook (IL), Dallas (TX), Hartford (CT), Irvine and Redwood City (CA), Miami (FL), New York (NY), King of Prussia (PA), River Vale (NJ), St. Paul (MN), and Falls Church (VA).

Nastec has international distributors in the U.K. (Hoskyns Group plc), Italy, France, Finland, Denmark, and Canada.

SAGE SOFTWARE, INC.
3200 Monroe Street
Rockville, MD 20852
(301) 230-3200

Kevin J. Burns, President and CEO
Public Corporation, OTC
Total Employees: 105
Total Revenue, Fiscal Year End
4/30/88: $14,569,558

The Company

Sage Software, Inc. develops, markets, and supports APS Development Center, an integrated family of computer-aided software engineering (CASE) application development tools, to developers of IBM-based business information systems. The company claims to be the only vendor to provide full function support for developing, generating, and testing applications in both the MVS and PC environments.

- Sage Software is the successor to the applications development software business begun in 1981 by Sage Systems, Inc.

- Sage Systems' original business of providing custom application software professional services to the federal government was formed as a separate company, Sage Federal Systems, Inc. (SFSI), and sold to certain officers and shareholders in March 1986 for $180,000.

  - SFSI has a nonexclusive, nontransferable 20-year license to distribute Sage Software's APS Development Center to the federal government.

- In December 1986, Sage Software made an initial public offering of 1.8 million shares of common stock, of which one million shares were sold by the company and 800,000 shares were sold by selling stockholders. Estimated net proceeds to the company were $11 million.

Sage Software's strategy is to continue to be a leading supplier of tools that automate the development of business systems on IBM computers.

- Sage Software management believes in a two-platform development strategy: Mainframe products based on ISPF in a TSO environment, running under MVS; and the use of IBM's PS/2 as a development workstation.

· Long-term planning is keyed on IBM's Repository product. Sage Software plans to develop a product that will emulate IBM's Repository.

Fiscal 1988 revenue reached $14.6 million, compared to $14.5 million in fiscal 1987. Net income declined 15%, from $1.8 million in fiscal 1987, to $1.5 million in fiscal 1988. A five-year financial summary follows:

SAGE SOFTWARE, INC.
FIVE-YEAR FINANCIAL SUMMARY
($ thousands, except per share data)

	FISCAL YEAR				
ITEM	4/88	4/87	4/86	4/85	4/84
Revenue · Percent increase from previous year	$14,570 --	$14,504 39%	$10,446 83%	$5,722 114%	$2,668 N/A
Income (loss) from continuing operations before taxes · Percent increase (decrease) from previous year	$2,276 (33%)	$3,371 58%	$2,133 99%	$1,070 358%	$(415) N/A
Income (loss) from discontinued operations (a)	--	--	$(296)	$(562)	$365
Net income · Percent increase (decrease) from previous year	$1,513 (15%)	$1,769 114%	$828 *	$68 (51%)	$138 N/A
Earnings (loss) per share from continuing operations	$0.30	$0.43	$0.35	$0.18	$(0.07)
Net earnings per share · Percent increase (decrease) from previous year	$0.30 (30%)	$0.43 79%	$0.24 *	$0.02 (50%)	$0.04 N/A

*   Percent change exceeds 1,000%.

(a)   Reflects income/losses associated with Sage Federal Systems, Inc. (SFSI) which was sold in March 1986. SFSI had revenue of approximately $9.4 million, $10.4 million, and $6.1 million for fiscal 1986, 1985, and 1984, respectively.

Sage Software management attributed fiscal 1988 results to the following:

- Revenue from the federal government was $4.3 million in fiscal 1988, a 32% decrease from $6.3 million in fiscal 1987.

  - Prior to December 1987, Results, Inc. had exclusive remote computing services rights to offer APS products in North America. In December 1987, Sage Software purchased the exclusive rights from Results for $1.8 million. Results also surrendered its right to offer APS products on a remote computing basis to any customer not under contract as of April 30, 1988.

    - Substantially all of the revenue derived from Results, Inc. related to services provided to the federal government.

    - Revenue derived from Results was approximately $2.8 million in fiscal 1988, compared to $3.3 million in fiscal 1987.

  - A spending freeze order by the Department of Defense has negatively impacted Sage Software's other government market distributor, SFSI.

- Sage Software's operating margins were negatively affected by the decline in federal revenue. Due to certain agreements with Results, the margin of content of this revenue source was much higher than that associated with nonfederal revenue. Therefore, operating income from continuing operations as a percent of total revenue was approximately 10% in fiscal 1988, 21% in fiscal 1987, and 21% in fiscal 1986.

- Sage Software has taken steps to reduce its expenses overall while continuing to make operational investments in its nonfederal revenue channels.

Product development expenses (before the capitalization of software development costs) were approximately $4.6 million (31% of revenue) in fiscal 1988, $4.4 million (30% of revenue) in fiscal 1987, and $2.7 million (26% of revenue) in fiscal 1986.

Revenue for the three months ending July 31, 1988 reached $3.6 million, a 27% increase over $2.8 million for the same period in 1987. Net income declined 55%, from $243,000 last year to $109,000 in the current quarter.

- Growth from the international and U.S. commercial markets accounted for over 95% of revenue. Approximately 65% of revenue came from new business, 15% from add-on products, and 20% from maintenance and training services.

- It is anticipated that fiscal 1989 revenue from commercial U.S. and international markets will increase 40% to 50%.

Sage Software has several marketing agreements with other vendors as follows:

- In August 1988 Sage Software signed an agreement with Perot Systems Corporation permitting Perot Systems to market Sage Software's APS products on a nonexclusive basis to the federal government and to provide training and services to APS users in North America.

- In August 1988 Sage Software formed a marketing alliance with Micro Focus Limited. Under the terms of the agreement, Sage Software will sell and provide frontline support for the Micro Focus family of PC-DOS and OS/2 products in conjunction with Sage Software's APS/PC Workstation. Sage Software and Micro Focus will work jointly with large strategic accounts; Micro Focus will provide initial training for Micro Focus products. This agreement covers all Micro Focus products and is worldwide in scope.

- In October 1988 Sage Software announced a marketing agreement with XDB Systems, Inc. of College Park (MD). The agreement permits Sage Software to market XDB Systems' XDB (a data base management system for microcomputers that emulates IBM's DB2) with Sage Software's APS/PC Workstation.

As of April 30, 1988 Sage Software had 105 employees, segmented as follows:

U.S. field sales and support	38
Research, development, and technical support	51
General and administrative	16
	105

Sage Software's primary competitor is Pansophic Systems and its TELON product.

Key Products and Services

One hundred percent of Sage Software's revenue is derived from its CASE software product licenses, maintenance fees, and royalties. A further breakdown of source of revenue follows:

SAGE SOFTWARE, INC.
THREE-YEAR SOURCE OF REVENUE SUMMARY
($ millions)

ITEM	FISCAL YEAR					
	4/88		4/87		4/86	
	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL
End-user revenue						
• Licenses (a)	$10.6	73%	$10.2	70%	$6.6	63%
• Maintenance fees (a)	0.9	6%	0.7	5%	0.5	5%
Royalties						
• Remote computing	2.8	19%	3.3	23%	3.2	31%
• Software vendor						
. licensing	0.3	2%	0.3	2%	0.1	1%
TOTAL	**$14.6**	**100%**	**$14.5**	**100%**	**$10.4**	**100%**

(a)   INPUT estimates for fiscal 1988 only.

The APS Development Center is a family of application development tools for developers of COBOL-based batch and on-line systems. These products support the application development process, including physical design, interactive prototyping, application generation, testing, and maintenance.

• Sage Software's APS/MVS Workstation application development tools are designed for IBM and compatible mainframes operating under MVS.

- In 1988 Sage Software introduced a new version of the APS/MVS Workstation. The mainframe environment is now completely ISPF-based. New prototyping capabilities permit users to simulate live data and show the movement of data from screen to screen. While viewing a prototype, users can dynamically modify screens.

- As of April 30, 1988 over 4,500 developers were using Sage Software's mainframe products at more than 150 customer sites.

- The APS/PC Workstation, announced in July 1988, is a full-function application generator to support the development of COBOL applications from physical design and prototyping, through generation and unit testing, totally independent of the mainframe.

  - Based on IBM's PS/2 and the Micro Focus COBOL/2 Workbench, APS/PC Workstation generates applications for execution in either the PC or the MVS environment.

  - The recommended environment for the APS/PC Workstation is an IBM PS/2 Model 70 or 80, 3 megabytes of extended memory, 640K RAM, a 5-megabyte hard disk, PC DOS 3.3, and the Micro Focus COBOL/2 compiler.

  - Typical configurations range in price from $5,000 to $7,500, depending on the data base and data communications targets chosen.

The APS/PC Workstation and APS/MVS products consist of several components surrounding a centralized application dictionary. These components can be configured to meet specific customer requirements for individual projects or as a complete development center.

- The APS Application Dictionary serves as the data store for the entities and rules required to generate code. It automatically creates documentation and produces a variety of reports.

- The APS Application Painters clarify user requirements and ensure conformance to real-world business goals.

  - The Application Painters create working models of the application system with four interactive tools - Screen, Report Mock-Up, Scenario Prototype, and Data Structure Painters.

  - The Application Painters offer a choice of working "top down" from a system-wide view or "bottom up". Prototyping can occur at three levels: screens, processes, and logical data.

  - Because the Application Painters automatically populate the Application Dictionary, any work done during prototyping is carried through the rest of the development cycle.

- The APS Importers leverage physical design and analysis efforts by extracting information from front-end design tools and

existing source code. This information includes data base models, screen designs, and report layouts. The APS Importers stretch APS product coverage into re-engineering as well as new development.

- Sage Software's first Front-End Importer is the Excelerator Integrator. Excelerator is a front-end design tools developed and marketed by Index Technology.

• The APS Logic Painters have a layered architecture that supports simple to very complex application requirements without coding at the native level. The Logic Painters, which reportedly deliver a productivity gain ranging from 8:1 to 12:1, consist of Online Express and Program Painters.

- Online Express is a nonprocedural "fill-in-the-blanks" approach to completing applications. Online Express enables programmers to specify single function or multiple function programs that use single or multiple screens.

- The Program Painter is integrated with Online Express. When data management and data communication logic is complex or unique, the Program Painter handles it, saving developers from the free-fall to native DB/DC calls and line-by-line COBOL. The Program Painter consists of a Logical View DB/DC facility, intelligent editor services, and a high-level specification language patterned after COBOL.

• The APS Generators produce clean, efficient DB/DC COBOL applications. They integrate pre-existing information (via the Importers) with the prototype, physical design, and logic specifications to generate 100% of the code required for the DB/DC environment - in top-down, structured, compiler-ready source. APS Generators are available for the following target environments:

- PC Targets:

    Micro Focus PC-CICS
    Micro Focus PC-IMS DC
    XDB Systems XDB/SQL
    Micro Focus PC-IMS DB
    Micro Focus PC-V-ISAM
    Micro Focus COBOL/2

- MVS Targets:

  CICS
  IMS DC
  DB2
  IMS DB
  VSAM
  COBOL and COBOL II
  IDMS

- The APS/DB2 Data Base Painter (DB2P) can be used as an optional, standalone data administration tool for defining DB2 objects or as an integrated tool with other APS Development Center Products for development of DB2 application systems.

  - DB2P provides a "staging area" for defining, storing, and modifying information for the DB2 system catalog. It enables DB2 analysts, programmers, and data base adminstrators to analyze the impact of changes via analysis reports before updating the DB2 system catalog.

  - Column independence provides additional flexibility by eliminating redundant column definition and maintenance.

- APS Link provides APS/PC-to-APS/MVS connectivity. With APS Link, entire applications, specific dictionary entities, and source code can be move with a single keystroke. APS Link allows the user to define work and project groups to facilitate source file maintenance on the PC.

- The optional APS Customization Facility creates usable logic, increasing productivity. The APS Generators operate from a preloaded rule base stored in the Application Dictionary. The Customization Facility allows the user to modify and extend these rules. Once the new rules are entered into the Application Dictionary, they can be invoked by the Logic Painters as an intrinsic part of the development environment.

Sage Software provides the following support services to its clients:

- Implementation planning.
- Training and consulting services.
- Documentation.
- 24-hour 800 answerline.
- APS/LINE newsletter.

Industry Markets

Approximately 79% of Sage Software's fiscal 1988 revenue was derived from end users in a range of industries (including 11% from the federal government); 19% was derived from Results, Inc., the company's licensed remote computing services vendor that provided services to the federal government; and 2% was derived from third-party software vendors.

- When Results, Inc.'s client base is factored in, approximately 70% of Sage Software's total fiscal 1988 revenue was derived from commercial clients and 30% was derived from the federal government.

- Sage Software management believes that the deterioration of revenue from federal government sources will continue at an accelerated rate due to the changes in its relationship with Results and in federal government procurement practices. Management's expectation is that revenue from the federal government will not exceed 10% of total revenue in the future.

APS is used by clients in the banking and finance, discrete and processing manufacturing, retail, telecommunications, and transportation industries, as well as state government. Customers include large operations that buy licenses for multiple sites as well as smaller, single-site users.

Clients added during fiscal 1988 include Arbitron (Control Data Corporation), Capitol Records, GTE, Marion Laboratories, MTech, Sovran Financial, Aeritalia, and Barclays Bank.

Geographic Markets

Approximately 82% of Sage Software's fiscal 1988 revenue was derived from the U.S. and 18% from international sources.

A three-year summary of geographic source of revenue follows:

SAGE SOFTWARE, INC.
THREE-YEAR GEOGRAPHIC SOURCE OF REVENUE SUMMARY
($ millions)

	FISCAL YEAR					
	4/88		4/87		4/86	
ITEM	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL	REVENUE $	PERCENT OF TOTAL
U.S.	$12.0	82%	$12.7	88%	$10.2	98%
International	2.6	18%	1.8	12%	0.2	2%
TOTAL	$14.6	100%	$14.5	100%	$10.4	100%

Sage Software has field sales and support offices in Atlanta, Boston, Chicago, Dallas, Los Angeles, New York, San Diego, and Washington, D.C.

Internationally, Sage Software sells its products through distributors. The company has distributors in Australia, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Norway, Sweden, Switzerland, and the U.K.

SOFTLAB INC.
188 The Embarcadero
Bayside Plaza, 7th Floor
San Francisco, CA 94105
(415) 957-9175

Bob Coolidge, President
Wholly Owned Subsidiary of Softlab GmbH
Total Employees: 29
Total Revenue, Fiscal Year End
9/30/88: $2,200,000

The Company

Softlab Inc. markets and supports the MAESTRO^R computer-aided software engineering (CASE) environment.

- Softlab Inc. was established in 1986 as a wholly owned U.S. subsidiary of Softlab GmbH, a German software and consulting firm that is active in the European and U.S. markets. Softlab GmbH employs approximately 520 people and generated $72 million in revenue worldwide during fiscal 1988. During 1987, car manufacturer BMW took a 28% share in Softlab GmbH for $42 million.

MAESTRO was developed by Softlab GmbH in cooperation with Philips. The company claims that MAESTRO is the "most successful dedicated software development system in the world". It currently has over 23,000 users in Europe and the U.S. at 480 sites.

Softlab Inc. generated an estimated $2.2 million in U.S. revenue during fiscal 1988. It is anticipated that fiscal 1989 revenue will reach $4.5 million. There are currently 17 MAESTRO installations in the U.S.

The company's strategy is to provide a full systems development life cycle support system and the professional servces required for successful implementation.

Competitors include Texas Instruments and KnowledgeWare.

Key Products and Services

MAESTRO is an integrated CASE environment that organizes and manages the software development life cycle through real-time project management, time accounting, and an organization's unique standards. The central information library (PLUS) links all members of the MIS team to one consistent repository of information. MAESTRO integrates customizable tools for analysis, design, coding, testing, documentation, and maintenance. It can be applied to virtually any life cycle, methodology, or programming language.

MAESTRO features include the following:

- Project management and time accounting system.

- Integrated data base and library management system.

- Interactive design systems.

- Syntax and consistency checking.

- Implementation and promotion of standards.

- Data dictionary.

- Programming language independence.

- Editing functions.

- Audit trails.

- Version control.

- JCL and code generators.

- User customizing through the procedure and rule-based languages.

- General office automation features, including information retrieval, word processing, electronic mail, automatic calculating, help functions, and on-line documentation.

The MAESTRO is a three-tier system with dedicated resources for software professionals that are distributed at the appropriate level.

- The first tier consists of the host, or target system where the software is ultimately designed to run. Compilation and testing are done on the target machine. Therefore, MAESTRO works with any language and with the latest available compiler.

- The second tier consists of departmental minicomputers that are the central coordinating and managing links of MAESTRO. Minicomputer systems can be linked together with MAESTRO/NET to provide a single-system image over hundreds of terminals.

- The third tier is the software professional's workstation – a terminal or microcomputer with the specialized functions that belong at the workstation.

MAESTRO runs on Motorola and DEC minicomputers.

MAESTRO is priced at $250,800 for a single multi-user system.

Industry Markets

The target market for MAESTRO includes systems development departments with 100 or more analysts and programmers.

Clients include the U.S. Air Force, Boeing, and United Airlines.

Geographic Markets

One hundred percent of Softlab Inc.'s revenue is derived from the U.S.

In addition to its headquarters in San Francisco, the company has offfices in Chicago and Washington, D.C. Future plans include opening offices in Boston, Dallas, and Los Angeles.

B

Appendix: CASE Product Profile

ANDERSEN CONSULTING
69 West Washington Street
Chicago, IL 60602
(312) 507-5161

Stanley L. Cornelison, Managing Partner
Unit of Arthur Andersen & Co.
Total Employees: 14,000
Total Revenue, Fiscal Year End
8/31/88: $1.12 billion

Background

Andersen Consulting helps clients use information in all phases of their management activities - strategic, operations, and financial. The group assists in the planning, design, and installation of computer-based information systems of all types and sizes for clients in almost every professional, business, and government sector. Andersen Consulting is part of The Arthur Andersen Worldwide Organization, providing professional services in accounting and audit, tax, professional education, and management information consulting to clients through 231 offices in 49 countries. The firm achieved revenue of $2.82 billion in fiscal 1988 and employs more than 39,000 professionals worldwide.

- In October 1988, Arthur Andersen & Co. announced its Management Information Consulting practice had been renamed Andersen Consulting in order to create a clear, separate identity for the firm's consulting services.

- Andersen Consulting, in addition to marketing and supporting the firm's FOUNDATION™ computer-aided software engineering (CASE) software product, provides services in systems design and installation, systems integration, systems productivity consulting, strategic consulting, change management, and facility/network management. The firm also offers application software products that support manufacturing resource planning and control and distribution control/warehouse management.

In March 1988, Arthur Andersen & Co. announced the availability of FOUNDATION, an integrated software development environment designed to support and automate the entire life cycle of application software development. FOUNDATION supports the planning, design, installation, and maintenance of mission-critical applications for IBM DB2 systems.

- The company's strategy regarding its CASE products is to provide an integrated set of tools and services designed to facilitate the adoption of CASE technology.

- FOUNDATION is an outgrowth of the advanced testing facilities, structured architecture, and standards developed by the company in providing custom systems development services to thousands of clients worldwide.

- FOUNDATION is the first CASE product to be offered by Arthur Andersen to the open market. Earlier versions of two of FOUNDATION's modules were available as separate products, but only to the company's existing clients.

The firm estimates that total worldwide revenues from FOUNDATION (including license fees, maintenance, support, and related services) reached approximately $28 million in fiscal 1988 and anticipates that fiscal 1989 revenue from FOUNDATION will reach $57 million.

Key Products

FOUNDATION consists of three integrated modules that together support the entire systems development process, eliminating redundancies, incompatible functions, and the multiple languages often found with single-function tools.

- FOUNDATION supports the development of transaction-oriented applications to run with DB2. It is based on an active design dictionary that is used to link the early phases of software analysis and design. The design dictionary is backed up by a DB2-based data dictionary. Data types, screen definitions, program definitions, DB2 table spaces, and table definitions can be transferred from the design dictionary to the data dictionary in order to install and maintain an application.

- FOUNDATION's components include the following:

  - METHOD/1™ is the PC-based, online, life cycle methodology that supports information planning, custom and iterative development, packaged systems implementation, and product systems support. METHOD/1 can be tailored to meet an organization's requirements for project management, work planning, estimating, scheduling, and change management.

    - METHOD/1 requires at least an IBM PC, XT, or AT with 20 mbyte hard disk, 512K of main memory, a system printer, and DOS Version 2.1 or later.

- METHOD/1 is priced at $50,000 for a single site. There are currently 535 installations.

- DESIGN/1™ is a PC-LAN-based set of software tools that automates systems design tasks and techniques to improve productivity and design quality. DESIGN/1 is used by analysts and designers to develop data flow diagrams, paint screens and reports, and for conversational prototyping. The product is mouse-driven, provides an easily followed menu-driven structure, and facilitates the sharing of design data. DESIGN/1 supports the activities of METHOD/1 and can be customized to support other methodologies.

  - DESIGN/1 requires at least an IBM PC with two 360K disk drives, IBM XT or AT, or compatibles, 512K of main memory, and DOS Version 2.1 or later.

  - DESIGN/1 is priced at $7,000 for the first site and $43,000 for a site with 40 users.

  - There are currently 5,000 DESIGN/1 installations.

- INSTALL/1™ is the mainframe environment for implementation and support of applications based on CICS, COBOL II, and DB2. It contains an extensible, active data repository built on IBM's DB2 relational data base system. INSTALL/1 provides facilities that assist in screen and dialogue·design, program generation, test data management, data and data base administration, and support of production systems. Design data can be uploaded from DESIGN/1 to INSTALL/1's data repository.

  - INSTALL/1 runs on IBM and compatible mainframes under MVS/XA, DB2, CICS, TSO/ISPE, COBOL II or OS COBOL.

  - INSTALL/1 is priced at $200,000 for a single site. There are currently 15 installations.

There are currently over 650 FOUNDATION clients. References are available upon request.

Future CASE product directions include industry-specific CASE tools and reverse engineering.

CHEN & ASSOCIATES, INC.
4884 Constitution Avenue
Suite 1E
Baton Rouge, LA 70808
(504) 928-5765

Dr. Peter P. Chen, President
Private Corporation
Total Employees: Under 30

Background

Chen & Associates, Inc., founded in 1978 by Dr. Peter Chen, provides computer-aided software engineering (CASE) software products, consulting, and training services in the area of systems analysis and design. The company specializes in strategic data planning, data modeling, data base design, and data base application development.

Chen & Associates has specialized in one of the most widespread approaches to data modeling: the Entity-Relationship (ER) approach. In addition to data model creation, the products offered by Chen & Associates also normalize the data within it, write the schema for the data base, and prepare it for uploading into the data dictionary. The company also offers several interface modules to customers as an incentive to link Chen products to those of other vendors that might currently be in use.

Key Products and Services

Chen & Associates' ER-Modeler product line creates and maintains data models in ER diagrams, normalizes them, and generates data base schemas for selected target data base management systems (DBMSs) or mainframe data dictionaries.

- The products run on IBM PC/AT, XT, PS/2, and compatible systems under MS/PC-DOS 2.X or 3.X. Also required are two disk drives and a graphics card (CGA, EGA, Hercules, and others).

ER-Modeler consists of five modules, as follows:

- ER-Designer defines entity relationships (ERs) by creating diagrams onscreen. ER-Designer has a data dictionary for storing and maintaining entities, relationships, and attributes. It also performs some consistency and validity checking.

- The ERs can specify the cardinality of the relationship, including its average value and upper limit, and the system can operate with both binary and multiple relationships.

- The ER diagram and its associated data dictionary contents can be printed on Epson, IBM, and Okidata dot-matrix printers, or on HP plotters/laser printers.

- The ReportGen program, included in ER-Designer, generates reports on data dictionary files.

- ER-Designer is priced at $495.

• SchemaGen converts ER diagrams into a particular DBMS schema (such as Ingres, ORACLE, Sybase, DB2, SQL/DS, IMS, IDS, IDMS, dBASE, DATACOM, Model 204, or Nomad) that can be uploaded into the mainframe or minicomputer that houses the DBMS.

- SchemaGen also includes a text editor.

- SchemaGen is available for the various DBMSs and is priced from $995.

• DDS-Link uploads the ER-Designer data files from microcomputer to mainframe data dictionary systems.

- Data dictionary formats currently supported include MSP's DataManager/Design Manager, IBM's DB/DC Data Dictionary, ADR's DATACOM, and Cullinet's IDD.

- DDS-Link is priced at $995.

• Normalizer reads either ER-Designer files or user-provided files in a specific format and normalizes relations to the Third Normal Form or Boyce-Codd Normal Form.

- Normalizer can be used as a standalone tool or as a companion product to ER-Designer.

- Normalizer is priced at $1,995.

• AutoDraw is an add-on product for ER-Designer that allows the user to enter entity names, relationship names, and attributes of an ER diagram and then transfer these files to ER-Designer for display as diagrams.

- AutoDraw is priced at $495.

                November 1988

The ER-Modeler package, including all five modules, is available from $3,495, depending on the DBMS version of SchemaGen selected. Quantity discounts are also available.

Interface modules are priced from $295 and are currently available for Nastec's DesignAid, KnowledgeWare's IEW, and Index Technology's Excelerator.

Three months of free maintenance support is included with each purchase. Thereafter, yearly maintenance contracts are available for 18% of the license fee.

Chen & Associates also provides CASE-oriented seminars/workshops in data modeling and data base design. These seminars are targeted to high-level administrators, designers, managers, analysts, and information system planners.

In addition to its headquarters in Baton Rouge, the company has a branch office in Palo Alto (CA).

COMPUTER ASSOCIATES INTERNATIONAL, INC.
711 Stewart Avenue
Garden City, NY 11530-4787
(516) 227-3300

Charles B. Wang, Chairman and CEO
Anthony W. Wang, President and COO
Public Corporation, NYSE
Total Employees: 6,000 (11/88)
Total Revenue, Fiscal Year End
  3/31/88: $709,109,000

Background

Computer Associates International, Inc. (CA), as a result of ongoing internal development and numerous acquisitions, currently markets and supports approximately 200 software products worldwide. CA's product line includes both systems and applications software for use on mainframes, minicomputers, and microcomputers.

CA's current strategy regarding CASE products is to provide back-end tools that create new COBOL applications and support existing applications.

In September 1988 CA introduced CA-UNIPACK/PPS in an effort to consolidate the array of programming productivity tools needed by application developers. CA-UNIPACK/PPS represents a repackaging of the company's CA-PROGRAMMERS' WORKCENTER™ product introduced in February 1987.

- CA-UNIPACK/PPS is marketed through CA's Information Products Division, which was created subsequent to the recent acquisition of Applied Data Research, Inc. (ADR). This new division combines virtually all of ADR's software product line with CA's programmer productivity and graphics products.

As a result of the acquisition of Applied Data Research, Inc. (ADR) earlier this year, CA management believes certain ADR resource management products (including ROSCOE, VOLLIE, and LIBRARIAN) will enhance its CA-UNIPACK/PPS product line.

Future CA CASE offerings will expand on ADR's IDEAL fourth-generation language foundation and will also include a strategy for DB2.

Key Products

CA-UNIPACK/PPS consists of CA component products for the applications programmer to facilitate the design, testing, and debugging phases of application development, and to optimize code that has been written into an application.

CA-UNIPACK/PPS consists of the following products:

- CA-FLEXISCREEN[R]: Ad Hoc Applications. This tool is used to generate a prototype of less complex CICS applications via a fourth-generation-language-style fill-in-the-blanks approach. The product includes a screen-chaining facility; supports BDAM, SAM, ISAM, and VSAM files; and offers access to DL/I data base files.

- CA-PROMACS[TM]: COBOL Application Generation. This tool produces both CICS and batch COBOL programs. The generated code is structured, documented, completely modifiable, and transportable. Routine programmer functions, such as reading files, writing output screens, and checking for end-of-file conditions, are generated automatically. The product allows existing COBOL statements, copybooks, and BMS (Basic Mapping Support) maps to be incorporated into the program, automatically placing them in the generated source code.

- CA-DATAMACS[TM]: Test Data Generation. This product is designed to facilitate regression testing. Control statements are placed in the Data Division and appear as comments to the COBOL compiler. The entire program or only the Data Division can then be processed by the data generator, and a test file is produced. Once testing is complete, the test file can be deleted and the control statements can remain within the program's Data Division. If changes are made to the program in the future, new control statements can be added to the old statements to create a new test file.

- CA-EZTEST[R]/CICS: CICS Testing and Debugging. This tool provides on-line interactive, CICS testing and debugging for COBOL, Assembler, and PL/I applications. Protection facilities in the module prevent test transaction program errors and control user access to storage.

- CA-OPTIMIZER[R]: COBOL Testing and Optimization. This product facilitates the batch testing and debugging processes. Data-related abends can be captured and documented by a report without interrupting processing. Multiple abends can be identified in one test run. Another facility produces a minidump at abend time that lists the actual source statement

that caused the problem, as well as probable causes and suggested solutions. Information on contents of buffers and registers at the time of the abend is also provided.

- CA-OPTIMIZER^R/II: COBOL II Testing and Optimization. This product performs the same functions as CA-OPTIMIZER on COBOL II.

- CA-EARL^R: Batch Report Generation. This product produces formatted reports from data files and provides information analysis facilities (including sorting and subtotaling), data manipulation, table lookup, and file maintenance.

- CA-DISSPLA^{TM} COBOL: COBOL Graphics. This is a COBOL-based graphics system for displaying COBOL application reports in the form of charts and graphs.

CA-UNIPACK/PPS products are available separately or as an integrated system through CAI's Information Products Division. The products run on IBM and compatible mainframes with the MVS or VSE operating system.

- Currently, clients are purchasing individual products within CA-UNIPACK/PPS at a far greater rate than purchasing the total package.

CA-UNIPACK/PPS ranges in price from $50,700 to $211,500, depending on the client's hardware configuration.

CA is currently developing CA-ADVISOR, a tool based on expert-system technology that aids in application development.

CULLINET SOFTWARE, INC.
400 Blue Hill Drive
Westwood, MA 02090
(617) 329-7700

John J. Cullinane, Chairman and CEO
Robert K. Weiler, President and COO
Total Employees: 2,000 (11/88)
Total Revenue, Fiscal Year End
4/30/88: $216,653,000

Background

Cullinet Software, Inc., founded in 1968, develops, markets, and supports software products for data base management, software development, artificial intelligence, and applications for manufacturing, human resources, distribution, project tracking, banking, and finance. The company has over 24,000 software product installations in over 60 countries worldwide.

Cullinet's computer-aided software engineering (CASE) software product, IDMS/ARCHITECT™, evolved from Auto-Mate Plus, originally designed by Learmonth & Burchett Management Systems of London (England). Cullinet purchased rights to the source code in 1986, and adapted the product to its IDMS/R relational data base management system.

Key Products

IDMS/ARCHITECT is a microcomputer-based tool that automates the analysis and design of applications and data base software.

- IDMS/ARCHITECT provides a diagram editor, a data base for storing designs, and reporting tools.

- Cullinet's ARCHITECT LINK™ is a micro-to-mainframe connection that transports designs and design details to IDMS/R's mainframe data dictionary, bridging the gap between logical and physical design. Developers can design a variety of data base and application components on the microcomputer and automatically generate many of the physical data structures needed to support the actual systems.

- The new release of IDMS/ARCHITECT, announced in October 1988, extends support for the design and generation of ADS/OnLine (Cullinet's fourth-generation language) applications and allows the downloading of existing IDMS/R schemas to the microcomputer.

- IDMS/ARCHITECT runs on IBM PC AT (and above) and compatible microcomputers under the MS-DOS operating system. It requires a minimum of 640K RAM and 17Mbytes of hard disk storage.

- The single-copy license fee for the standalone version of IDMS/ARCHITECT is $8,000. The single-copy license fee for IDMS/ARCHITECT with ARCHITECT LINK is $12,000. Volume discounts and site licenses are available.

- IDMS/ARCHITECT is currently installed at more than 500 customer sites.

Cullinet Education Services offers three IDMS/ARCHITECT courses to meet customer training requirements.

In subsequent releases of IDMS/ARCHITECT, Cullinet plans to expand the data base re-engineering capabilities to include the generation of SQL-based relational tables.

**MCDONNELL DOUGLAS
INFORMATION SYSTEMS
COMPANY**
P.O. Box 516
St. Louis, MO 63166
(314) 232-0232

Jeremy J. Causley, President
Operating Company of McDonnell
Douglas Corporation
Total Employees: 11,000 (12/87)
Total Revenue, Fiscal Year End
12/31/87: $1,241,800,000

Background

McDonnell Douglas Information Systems Company offers industry-specific solutions to the federal, state, and local government and the manufacturing, insurance, retail, and telecommunications industries, as well as cross-industry products and services, including systems integration application development tools; consulting, education, and systems development professional services; remote computing (utility processing) services; and network applications services for electronic mail and electronic data interchange (EDI).

The company's strategy with regard to its computer-aided software engineering (CASE) software line is to assist the information systems professional in developing and maintaining quality information systems in a more productive manner. This goal will be achieved by applying active automated software engineering technology to the complete systems development life cycle, including both forward and reverse application engineering of highly portable business information applications.

- Since the formation of McDonnell Automation Company (McAuto) in 1960, McDonnell Douglas has focused on the process of delivering high quality information systems. This included pioneering in the use of structured approaches to systems development in the mid-1970s and the evolution of · proven project management approaches to large-scale development projects.

- In March 1981, McDonnell Douglas purchased the assets of the Improved System Technologies (IST) company founded by Chris Gane and Trish Sarson. With that acquisition, the STRADIS software development life cycle methodology was introduced into both internal and commercial project environments at McDonnell Douglas. This foundation was then

reinforced with the real-world experience of the organization, yielding an enhanced version of the STRADIS methodology, which continues to evolve, providing context for the definition and development of McDonnell Douglas CASE products.

- McDonnell Douglas entered the CASE market in 1982 with the introduction of STRADIS/DRAW^R, an automated graphics system for IBM mainframes that interactively creates and updates two-dimensional structured diagrams.

- In 1985, McDonnell Douglas introduced ProKit*ANALYST^R, a PC-based automated graphics system that produces data flow diagrams and generates its own data dictionary.

- The company has also introduced several other PC-based graphics tools, including SCdraw^{TM}, for creating structure charts, and DFDdraw^{TM}, for creating and updating data flow diagrams.

- In September 1987, the company introduced the ProKit*WORKBENCH^R, a PC-based front-end CASE tool that brings together capabilities of earlier separate products with new capabilities, all integrated through a single object repository. This tool directly supports the systems planning, analysis, and design phases of the system development life cycle. Support for the remainder of the life cycle is provided through interfaces to McDonnell Douglas and third-party application generation products.

In addition to its software development tools and CASE product offerings, McDonnell Douglas also provides education and training and consulting services related to system development.

INPUT estimates ProKit*WORKBENCH sales were approximately $2 million in 1987, and that 1988 sales will reach an estimated $5 million.

In June 1988, McDonnell Douglas announced an interface between ProKit*WORKBENCH and Pansophic Systems' TELON application generator, giving its clients the ability to move into COBOL or PL/1 source code from ProKit*WORKBENCH.

In December 1987, McDonnell Douglas acquired PRO-IV, an application generation system, as part of the acquisition of Pro Computer Sciences, Inc. of Laguna Hills (CA). The company is committed to developing and commercially providing an interface between PRO-IV and ProKit*WORKBENCH.

McDonnell Douglas' competitors in the CASE area include Texas Instruments (Information Engineering Facility), KnowledgeWare (Information Engineering Workbench), and Index Technology (Excelerator).

Key Products and Services

ProKit*WORKBENCH proves data flow diagramming, entity modeling, prototyping, and an expanded data dictionary that underlies and unifies data from its various components.

- ProKit*WORKBENCH components include the following:

    - Data Modeler includes graphic and dictionary functionality required for data model development, using either Chen or Bachman graphic conventions.

    - Analyzer provides both graphic and dictionary support related to Gene & Sarson data flow diagramming techniques.

    - Prototyper provides a screen, menu, and report image painting and execution capability that can function independently or tightly linked to data dictionary contents.

    - Designer couples graphics support for Constantine-based structure charts with full dictionary support for the preparation of design deliverables, such as program specifications and test plans.

- With ProKit*WORKBENCH, all data diagrams and relationships are stored and managed in an active data dictionary. Each fact is stored one time and in one place. A change to a dictionary data element occurs across all diagrams and objects affected - no matter what function is being used.

- ProKit*WORKBENCH runs on IBM PC, XT, AT, PS/2, and compatible systems under PC-DOS or MS-DOS 3.0 or higher. The product is priced at $9,200.

- To date, over 900 units of ProKit*WORKBENCH have been sold (800 U.S. and 100 international).

The main benefit of using ProKit*WORKBENCH, as outlined by McDonnell Douglas, is that system development efforts are performed efficiently and with greater success. The user's time can be spent analyzing business needs and making professional decisions, rather than on manual drawing, checking, and reporting.

ProKit*WORKBENCH is marketed and supported through McDonnell Douglas Information System Company's Information Systems Engineering business unit.

McDonnell Douglas also provides public education courses on Structured Systems Analysis and Design and Analysis for Design Decisions, classes for licensees of its products, and consulting services.

PANSOPHIC SYSTEMS,
INCORPORATED
2400 Cabot Drive
Lisle, IL 60532
(312) 505-6000

David J. Eskra, Chairman and CEO
William G. Nelson, President
Public Corporation, NYSE
Total Employees: 1,350 (4/88)
Total Revenue, Fiscal Year End
4/30/88: $165,300,000

Background

Pansophic Systems, Incorporated, founded in 1969, develops, markets, and supports systems and application software products for mainframes, minicomputers, and microcomputers. The company's product lines address information technology needs in the areas of on-line applications development and library control and management (systems life cycle); information retrieval and data communications; manufacturing, distribution, and financial applications; and 2-D and 3-D presentation graphics software and turnkey systems. Pansophic currently has more than 50,000 installations of products at over 15,000 sites worldwide.

Pansophic's ultimate objective is to integrate all of Pansophic's system life cycle products to provide a complete CASE environment based on industry standard data dictionary technology.

- Pansophic is implementing the ANSI/OSI Information Resource Dictionary Systems (IRDS) Standard in the development of its Pansophic Resource Dictionary (PAN/RD). Pansophic states that PAN/RD is one of the first dictionary systems in the industry to implement the IRDS standards and the first to address issues of product compatibility, connectivity, and open architecture. As the foundation for the integration of Pansophic's CASE environment, it will be implemented in a relational DBMS and serve as a bridge to the IBM Repository.

- With PAN/RD forming the foundation, integration will include external analysis tools, data base design tools, external data dictionaries, and user applications.

Pansophic's currently offers a range of products that provide productivity gains and benefits for CASE implementation. TELON^R, Pansophic's application development and generator tool, has over 400 installations worldwide. TELON sales have

quadrupled in the past three years, with sales for fiscal 1988
increasing 82% over fiscal 1987.

- The change control capabilities of PANVALET^R, PANEXEC^R,
  and LCS^R/CMF, combined with the automated production
  turnover provided by PANAPT^{TM}, serve as a basis for control of
  the entire development process.

To encourage product linkages, Pansophic's CASE environment
fully supports strategic alliances with other software vendors,
providing end users with "best of breed" CASE solutions.

- Interfaces between TELON and Index Technologies'
  Excelerator, Nastec's DesignAid, and McDonnell Douglas'
  ProKit Workbench analysis and design tools are currently
  available.

- TEAMWORK/TELON combines TELON with
  TEAMWORK, Cadre Technologies' structured analysis and
  design product. Availability is scheduled for the first quarter of
  1989.

- In October 1988, Pansophic announced that in the first quarter
  of 1989 it will publish complete documentation for the TELON
  Transport Facility, its standard software interface that allows bi-
  directional transfer of data between CASE structured analysis
  and design tools and TELON, making the TELON Transport
  Facility available to other vendors for non-proprietary use.

- As a long-term direction for the CASE environment, Pansophic
  is exploring strategic relations with leading vendors of re-
  implementation tools. Re-implementation capabilities will be
  added to TELON, allowing it to reverse engineer and maintain
  current programs at the design level.

Key Products

TELON, introduced in 1984, is an application development system that captures design information from screen dialog and generates COBOL, PL/1, or COBOL II source programs for IMS/DB, CICS, and batch environments. TELON provides the ability to build and test complex application systems in standard language, thereby building upon developers' existing skills. TELON will automatically generate access to DB2, IMS/DB, VSAM, and sequential files from this design input.

TELON consists of integrated components that address all phases of the application development life cycle. TELON runs on IBM 370, 30XX, 43XX, and compatible mainframes under MVS/XA, SP, and VS1.

- The Analysis Tool Interface provides direct interfaces to most major front-end analysis and design software tools.

- The Data Dictionary Interface provides an import facility that allows the developer to bring in information from other data dictionaries, thereby eliminating the need to re-enter any existing data definitions.

- The TELON Dictionary is the application repository, where all the information about each application is stored and all data dictionary functions occur.

- The Data Administration Component allows multiple data bases or DB2 tables to be defined and maintained for use in applications.

- The application development process starts with the TELON Design Facility. The screen is the basic design unit in TELON, differing from the traditional transaction concept of IMS or CICS where attention centers around the transaction. In TELON, attention centers around the screen. To create a TELON on-line application, the programmer first designs a panel image by laying out the screen as it is to appear to the end-user and defines its fields.

- The TELON Prototyping Facility allows the developer to demonstrate real-life applications to the end user prior to generation and testing. Screen-to-screen flow, data presentation, field and special edits can all be shown without compiling a single program. The prototype evolves into the production program so there is no throw-away effort.

- The Specification Facility establishes the contents of the application, including routines in PL/1, COBOL, or COBOL II,

without any new procedural language or macro-programming. DBMS access and any reusable code, such as calculations, are also specified within this component.

- The TELON Generator generates structured, portable COBOL, COBOL II, or PL/1 code for IMS/DC, CICS, or batch applications.

- The TELON Test Facility completes the system by providing tracing and debugging. The Test Facility allows a developer to modify applications during a test session.

- Automated Documentation is generated from the Dictionary for maintenance estimates, project management, and system documentation.

- TELON ranges in price from $100,000 to $400,000.

TELON PC links the microcomputer to its mainframe. Components such as the TELON Design Facility and Prototyping Facility are maintained in both environments. TELON PC brings the speed of the PC to the development of mainframe applications, especially for functions like designing screens, prototyping, and specifying requirements. Revised programs can then be returned to the mainframe for generation and testing.

- TELON PC runs on the IBM PC/XT, XT 3270 Model 6, PC/AT 3270 Model 6, and compatibles under PC-DOS.

- TELON PC is priced at $9,500 for a single copy. Volume pricing is available.

TELON customer references include Westinghouse, Consolidated Natural Gas, J.C. Penney, Marine Midland Bank, Aer Lingus, General American Life Insurance, Blue Cross and Blue Shield of Minnesota, and Baxter Travenol.

CASE PRODUCT PROFILE

TEXAS INSTRUMENTS INCORPORATED
P.O. Box 869305
MS 8474
Plano, TX 75086
(214) 575-4404

Jerry Junkins, President and CEO
Public Corporation, NYSE
Total Employees: 78,000
Total Revenue, Fiscal Year End
12/31/87: $5.6 billion

Background

Texas Instruments Incorporated (TI) provides a range of products in the electrical and electronics industry for industrial, consumer, and government markets.

In early 1983 TI formed a dedicated organization to develop the Information Engineering Facility ™ (IEF™), an integrated set of commercially available tools to automate the entire systems life cycle and improve the quality and productivity of business information systems development.

- TI commited to adopt the Information Engineering methodology described by James Martin that focuses on shared data for building systems. TI funded research by James Martin Associates to define, in detail, the Information Engineering methodology and to assist in the design of IEF's mainframe encyclopedia, the repository for all facts collected about business problems and their systems solutions.

- IEF was first introduced by TI in 1984 for internal use and since June 1987 has been available commercially. The product is marketed through TI's Information Systems and Services, Advanced Information Management unit headquartered in Plano (TX).

TI claims that IEF, which incorporates a fully integrated architecture to automate the entire business information systems development life cycle, is the only truly integrated CASE product commercially available. IEF also generates 100% of COBOL and data base code from its diagrams.

In calendar 1988, its first full year in the CASE market, TI will derive an estimated $15-$20 million in IEF product and support services revenue, exceeding management's projections.

Key Products and Services

IEF automates the entire systems life cycle, from information strategy planning through systems analysis, design, systems generation, maintenance, and documentation. It can be used to produce software systems for such applications as cost accounting, personnel, facilities, production, and other business functions.

- IEF develops on-line applications supporting MVS environments for IMS DC/DB2, CICS/DB2, TSO/DB2, or other compatible SQL-based DBMS products.

IEF consists of five integrated toolsets that are linked and coordinated through a central mainframe repository of both detailed systems information and systems development rules.

- IEF performs its planning (Planning Toolset), analysis (Analysis Toolset), design modeling (Design Toolset), and specification functions on intelligent desktop workstations.

  - The operating environment for these workstation toolsets is PC-DOS or MS-DOS 3.0 or higher on IBM PC/AT or PS/2 Models 50, 60, and 80, and compatible systems.

  - With its interactive color graphics, pop-up menus, and on-line help, the information is converted into data relationships and diagrams. Diagramming tools include Entity-Relationship, Entity Hierarchy, Process Hierarchy, Process Dependency, Process Action, Dialog Flow, Screen Design, Procedure Action, Data Structure diagrams, and business function/entity-type usage matrices.

- The design diagrams are then fed into the mainframe, where the code generator, central encyclopedia, data base generator, and a public interface tool all reside. The operating environment for IEF's mainframe components is MVS, in conjunction with DB2, TSO/E, ISPF Version 2.2, VS COBOL II.

  - The Central Encyclopedia acts as the mainframe repository for all business and systems information collected by the workstation toolsets. It contains the meaning of the diagrams from which full code can be generated automatically.

  - The Code Generation Toolset produces IBM's VS COBOL II program code.

  - The Data Base Generation Toolset generates the system control information needed for data storage and access.

- A public interface provides an import/export capability to support migration to interface with other environments, and to facilitate query reporting.

- Documentation, which resides in the encyclopedia, is always current because the documentation itself is used to generate the system.

Pricing for IEF components is as follows:

• The bundled price for the workstation components (Analysis Toolset, Planning Toolset, and Design Toolset) is $13,900.

• The bundled price for the mainframe components (Central Encyclopedia, Code Generation Toolset, and Data Base Generation Toolset) is $265,000.

• One year of maintenance is included with the purchase price. Thereafter, annual maintenance contracts are available for 15% of the current purchase list price.

There are currently over 120 IEF customers worldwide.

Support services provided by TI for IEF include the following:

• Education workshops, provided at client sites or TI's Dallas training center, address both practical use of IEF and the concepts of the Information Engineering Methodology.

• Consulting support includes planning projects and the introduction of the IEF, providing methodology expertise and guidance, and reviewing the systems development work done by the customer.

• Reference guides available to customers include methodolgy guides for the planning, analysis, and design stages of information engineering; toolset guides with step-by-step instructions; and a glossary of information engineering terms.

• Customer services include installation support, hotline services, free maintenance for the first year following initial purchase, an IEF users group, and newsletters.

IEF is marketed worldwide by TI. James Martin Associates Ltd and its subsidiary, Information Engineering Products, markets IEF in Europe.

TI is commited to the CASE market. Three research and development organizations within TI are addressing IEF and the future of CASE. Topics being explored include: the incorporation of additional CAD/CAM techniques; artificial intelligence; object-oriented data bases; data base optimization; re-engineering capabilities; encyclopedia administration; and end-user computing.

- IEF will be expanded to support other data base management systems (including ORACLE) and other operating systems (including UNIX) in an effort to broaden its target markets.

- A goal is to strive for total environmental independence in the system life cycle, up to code generation.

- In the 1990's TI CASE products will address the engineering of real-time embedded systems.

IEF customers such as Arthur D. Little, Touche Ross, Computer Task Group, and CACI Federal use IEF in working with their clients. Other IEF customers include Huntington National Bank of Columbus (Ohio) and Scott Paper Company.
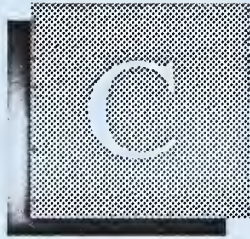
Appendix: Application Development Questionnaire

Appendix C

CONFIDENTIAL

INPUT
INFORMATION SYSTEMS PROGRAM
1988 ANNUAL PLANNING REPORT
APPLICATION DEVELOPMENT QUESTIONNAIRE

INTRODUCTION

A.   Hello, my name is _____. I am calling for INPUT, a leading market research firm specializing in the information systems industry. I would like to speak to the individual responsible for the applications development function. Would you be the appropriate individual to respond to a questionnaire on this area? It should take only 10 minutes, and INPUT will be pleased to share a summary of the results with you. **If switched elsewhere for referral, repeat as necessary; OTHERWISE GO TO C.**

B.   Hello my name is _____. I understand you are responsible for the information systems application development function. I am calling for INPUT, a leading market research firm specializing in the information systems industry, and would like to ask you a few questions.

Would you or an associate have a few moments now, or would you prefer that we set an appointment for another time? It should take only 10 minutes, and INPUT will be pleased to share a summary of the results with you. **If the correct person proceed to C or make an appointment to call back, otherwise transfer and repeat.**

C.   We are currently studying a number of issues in the applications development area, in particular the issue of development productivity. Your responses to the questions will be kept confidential and, as I mentioned, INPUT will send you a complimentary summary of the results.

Individual completing the Questionnaire

Name   _____
Title   _____
Organization   _____
Address   _____
                _____
Telephone   _____

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The first group of questions will help us understand your application development organization.

1.   What is the total number of people in:

1a.   Information Systems (companywide)? _____ .

1b.   Applications Development (companywide)? _____

2a.   Is the development staff centralized or decentralized?
Centralized____ **GO TO 3**   Decentralized ____

2b.   **If decentralized ASK** Please estimate the percent of the development staff in the following categories? **PROBE FOR A GUESS**

Corp Information Systems	____%
Corporate Departments	____%
Operating Divisions	____%
Subsidiaries	____%
Total	100%

3.   What percent of applications development staff is assigned to: **PROBE FOR A GUESS**.

Developing new systems	____%
Maintaining existing systems	____%
Enhancing existing systems	____%
Total	100%

The next group of questions look at your applications development backlog and major project plans.

4a.   Over the past year, has your application backlog increased, decreased, or remained the same?

__ Increased **GO TO 4b**
__ Remained the Same **GO TO 4b**
__ Decreased **GO TO 4c**

4b.   **If Increased or Remained the Same ASK** What are the major constraints on your firm's ability to reduce the application backlog? For example, a decision to replace all manufacturing systems.

      1.   _____

      2.   _____

      3.   _____

4c.   **If Decreased ASK** What are the major factors that enabled you to reduce the backlog? For example, using a fourth generation language.

1. _____

2. _____

3. _____

5.   **Using the table below ask the following questions:**

5a.   During the next 12 months, what are the most important application development projects? **PROBE FOR AT LEAST THREE EXAMPLES.**

For each project (application) mentioned in 5a ask:

5b.   What type of resources will be used: internal staff, external professional services, or combination?

5c.   Will you purchase the system?

5d.   What is the estimated total development cost?

5a Application	5b Dev. Resource Int Ext	Soft Comb	5c Cost Pkg	5d ($000)
_____	____ ____	____	Y N	____
_____	____ ____	____	Y N	____
_____	____ ____	____	Y N	____
_____	____ ____	____	Y N	____

6a.   Now for all of your major development projects please estimate the percentage that will be done using internal, external, or a combination of resources:

6a.1   Internal resources   ____%
6a.2   External resources   ____%
6a.3   Combination of resources   ____%

6b.   And what percentage will be done using purchased software versus custom development:

6b.1   Purchased software   ____%
6b.2   Custom development   ____%

6c.   You indicated that you will do about ____% (INSERT RESPONSE TO 6a.2) of your new applications development with external, that is, professional services resources. Is this more, the same or less external support than in 1987?

More ____
Same ____
Less ____

The next group of questions address productivity within the corporate or central application development organization.

7a.   What are the top three issues concerning application development within your firm? **If productivity mentioned go to 7c.**

1. _____
2. _____
3. _____

7b.   You did not mention application development productivity, is it a critical issue?
Yes ____ No ____ **GO TO 8**

7c.   Is development productivity more critical, less critical, or about the same as in previous years?

More ___   **GO TO 7d**
Less ___   **GO TO 7e**
About the Same ___ **GO TO 8**

7d.   Why is it more critical? _____

_____**GO TO 8**

7e.   Why is it less critical? _____

_____

8a.   Is application development productivity currently measured?
Yes ____ No ____**GO TO 8e**

8b.   **If Yes ASK** How is it measured? For example, lines of code per day.

_____

8c.   What are the advantages of the measurement used?

_____

_____

8d.   What are the disadvantages of the measurement used?

_____

_____GO TO 9a

8e.   **If No ASK** Why not? _____

9a.   Is a systems development methodology in use?
Yes _____   No _____ **GO TO 10a**

9b.   **If yes ask** Which one? **READ LIST**

     _____   Stratus
     _____   Yourdon
     _____   SDM/70
     _____   IBM Business Systems Planning
     _____   In-house developed
     _____   Other (specify) _____

10a.   Are fourth generation languages used?
Yes _____   No _____ **GO TO 10d**

10b.   **If Yes ASK** Which ones?   **READ LIST**

     Focus _____   Ideal   _____
     Ramis _____   Cognos _____
     Mantis _____   Other   _____ (specify) _____
     Natural_____

10c.   Please provide examples of how your firm uses fourth generation languages? For example, prototyping or report generation. **PROBE FOR 3 EXAMPLES**

     10c.1_____
     10c.2_____
     10c.3_____GO TO 11a

10d.   **If No ASK** Why not? _____

11a.   Are any Computer-Assisted Software Engineering (CASE) tools in use?
Yes _____ No _____ **GO TO 11e**

11b.　**If Yes ASK** Which ones?　**READ LIST AS PRODUCT NAME FROM VENDOR NAME**

　　　　Product (Vendor)
____　Excelerator (Index Technology)
____　Application Factory (Cortex)
____　APS Development Center (Sage Software)
____　Prokit Workbench (McDonnell Douglas)
____　Foundation (Arthur Andersen)
____　Information Engineering Workbench (KnowledgeWare)
____　Analyst/Designer Toolkit (Yourdon)
____　Telon (Pansophic)
____　Other (specify) _____

11c.　What are the strengths of these tools?

_____

11d.　What are the weaknesses of these tools?

_____**GO TO 11f**

11e.　**If No ASK** Are any under consideration?
　　　Yes ___　　　No ___ **GO TO 12**

11f.　**If yes ASK** Which ones?

_____

12.　Is there an organized project addressing application development productivity?
　　　Yes____ No____ **GO TO 14a**

13.　**If Yes ASK** Please provide the name of the Development Manager or project leader who might participate in a more in depth interview.

　　　　Name　　　_____
　　　　Title　　　　_____
　　　　Phone No.　_____

The final group of questions asks about the involvement of the end user in application development at your firm.

14a.　Does your firm have an information center; that is, a group that is directly responsible for end user computing?
　　　Yes __ NO __ **GO TO 15**

14b.　How many Information Centers are there? _____

14c.   Do the Information Centers report to: **READ LIST**

     1. Information Systems?   Y   N
     2. User Departments?   Y   N
     3. Operating Divisions?   Y   N
     4. Subsidiaries?   Y   N

15a.   Are end users developing their own production applications or is their development limited to personal productivity programs? For example a departmental project control system would be a production system while analyzing a specific project with Lotus 1-2-3 would be a personal productivity application. **READ LIST**

     All Production ___   Some Prod. ___   Personal Only ___ **GO TO 16**

15b.   On which type of computer(s) are the production systems being developed?
     Mainframe ___   Mini ___   PC ___

15c.   Please provide examples of user developed production applications?

     15c.1 _____
     15c.2 _____
     15c.3 _____

16.   Now, estimate the percentage of all new application development that is being done by end users? **PROBE FOR A GUESS** ____%

17.   INPUT will also be researching trends in data administration during 1988. Would you provide us with the name of the manager of your data administration (management) department?

     Name _____
     Title _____
     Phone No. _____

That's it! I want to thank you for your help today. Let me double check your address in order to send you a synopsis of the report. Thanks again.

D

Appendix: CASE Implementation Questionnaire

Appendix D

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Confidential

INPUT
Application Development
CASE Implementation Questionnaire

1a.   Do you use a systems methodology?

Yes ___   No ___

1b.   If Yes, Which one?   _____

1c.   How long has it been in use? ____ years

2a.   Are fourth generation languages in use?

2b.   If yes, which ones and for how long?

Language   Length of Use

_____   _____

_____   _____

_____   _____

3a.   Are Computer Aided Software Engineering (CASE) tools in use?

Yes ___   No ___

3b.   Which ones (classify each)?

Product   Classification

_____   _____

_____   _____

_____   _____

_____   _____

4a.   What is the status of the use of these tools?

____   Investigation
____   Prototype
____   Single New System
____   Multiple New Systems
____   Enhancement of Existing System
____   General Use

4b.   How were these CASE tools selected?

_____

_____

_____

_____

4c.   What are the current objectives of your use of CASE?

_____

_____

_____

_____

4d.   What training is being used to implement CASE?

_____

_____

_____

_____

5a.   What is the project(s) to which CASE tools are being applied?

_____

_____

_____

_____

                         MCAS

5b.   What problems have been encountered to date?

_____

_____

_____

_____

6a.   Is there a plan to use CASE technology with existing versus new systems?

Yes ___   No ___

6b.   How will this be done?

_____

_____

_____

6c.   Are additional CASE tools under consideration?

Yes ___   No ___

6d.   Which ones?

_____

_____

7a.   What is the overall reaction and level of satisfaction with CASE to date?

_____

_____

_____

7b.   What is the level of satisfaction with the CASE vendor(s)?

_____

_____

THANK YOU

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